Graduate School–New Brunswick Catalog 2003–2005

Contents

Important Notice

THE STATE UNIVERSITY OF NEW JERSEY

RUTGERS

New Brunswick/Piscataway

Academic Calendars

Dates are subject to change.

2003–2004

September
2   Tuesday   Fall term begins.

November
25   Tuesday   Thursday classes meet.
26   Wednesday   Friday classes meet.
27   Thursday   Thanksgiving recess begins.
30   Sunday   Thanksgiving recess ends.

December
10   Wednesday   Regular classes end.
11   Thursday   Reading period.
12   Friday   Reading period.
15   Monday   Fall exams begin.
22   Monday   Fall exams end.
23   Tuesday   Winter recess begins.

January
19   Monday   Winter recess ends.
20   Tuesday   Spring term begins.

March
14   Sunday   Spring recess begins.
21   Sunday   Spring recess ends.

May
3   Monday   Regular classes end.
4   Tuesday   Reading period.
5   Wednesday   Reading period.
6   Thursday   Spring exams begin.
12   Wednesday   Spring exams end.
20   Thursday   University commencement.

2004–2005

September
1   Wednesday   Fall term begins.
6   Monday   Labor Day—No classes.

November
24   Wednesday   No classes.
25   Thursday   Thanksgiving recess begins.
28   Sunday   Thanksgiving recess ends.

December
13   Monday   Regular classes end.
14   Tuesday   Reading period.
15   Wednesday   Reading period.
16   Thursday   Fall exams begin.
23   Thursday   Fall exams end.
24   Friday   Winter recess begins.

January
17   Monday   Winter recess ends.
18   Tuesday   Spring term begins.

March
13   Sunday   Spring recess begins.
20   Sunday   Spring recess ends.

May
2   Monday   Regular classes end.
3   Tuesday   Reading period.
4   Wednesday   Reading period.
5   Thursday   Spring exams begin.
11   Wednesday   Spring exams end.
19   Thursday   University commencement.

About the University

Rutgers, The State University of New Jersey, with more than 50,000 students on campuses in Camden, Newark, and New Brunswick, is one of the nation's major state university systems. The university comprises 29 degree-granting divisions: 12 undergraduate colleges, 11 graduate schools, and 6 schools offering both undergraduate and graduate degrees. Five are located in Camden, 8 in Newark, and 16 in New Brunswick.

Rutgers has a unique history as a colonial college, a land-grant institution, and a state university. Chartered in 1766 as Queen's College, it was the eighth institution of higher learning to be founded in the colonies. The school opened its doors in New Brunswick in 1771 with one instructor, one sophomore, and a handful of first-year students. During this early period, the college developed as a classical liberal arts institution. In 1825, the name of the college was changed to Rutgers to honor a former trustee and Revolutionary War veteran, Colonel Henry Rutgers.

Rutgers College became the land-grant college of New Jersey in 1864, resulting in the establishment of the Rutgers Scientific School with departments of agriculture, engineering, and chemistry. Further expansion in the sciences came with the founding of the New Jersey Agricultural Experiment Station in 1880, the College of Engineering in 1914 (now the School of Engineering), and the College of Agriculture (now Cook College) in 1921. The precursors to several other Rutgers divisions also date from this period: the College of Pharmacy in 1892 (now the Ernest Mario School of Pharmacy), the New Jersey College for Women (now Douglass College) in 1918, and the School of Education (now a graduate school) in 1924.

Rutgers College became a university in 1924. The legislature passed laws in 1945 and 1956 designating all divisions of Rutgers as the state university of New Jersey. During these years, the university expanded dramatically. An evening division, University College, opened in 1934. The University of Newark joined the system in 1946, and the College of South Jersey at Camden was added in 1950.

Since the 1950s, Rutgers has continued to expand, especially in graduate education. The Graduate School–New Brunswick, the Graduate School–Newark, and the Graduate School–Camden serve their respective campuses. In addition, the university has established professional schools in applied and professional psychology; communication, information, and library studies; criminal justice; the fine arts; management; and social work. Several of these schools offer undergraduate programs as well. In 1969, the university founded Livingston College to provide undergraduate degrees to a diverse community of students.

Today, Rutgers continues to grow, both in its facilities and in the variety and depth of its educational and research programs. The university's goals for the future include the continued provision of the highest quality undergraduate and graduate education along with increased support for outstanding research to meet the needs of society and to fulfill Rutgers' role as the state university of New Jersey.

Institutional and Specialized Accreditation

Rutgers, The State University of New Jersey, is accredited by the Commission on Higher Education of the Middle States Association of Colleges and Schools, 3624 Market Street, Philadelphia, PA 19104-2680 (215/662-5606, *http://www.msache.org/*). The Commission on Higher Education of the Middle States Association of Colleges and Schools is an institutional accrediting agency recognized by the U.S. secretary of education and the Council for Higher Education Accreditation. That accreditation was renewed and endorsed in 1998. Documents describing the institution's accreditation may be downloaded from the university's web site at *http://oirap.rutgers.edu/reports/MSA/index.html*. They may be reviewed during regular office hours by contacting the Office of Institutional Research and Academic Planning, Rutgers, The State University of New Jersey, 85 Somerset Street, New Brunswick, NJ 08901-1281 (732/932-7956).

Certain undergraduate programs on the Camden, Newark, and New Brunswick campuses of Rutgers are subject to specialized accreditation. For further information about specialized accreditation, including the names of associations that accredit university programs, contact the Office of Institutional Research and Academic Planning.

Licensure

Rutgers, The State University of New Jersey, is licensed by the New Jersey Commission on Higher Education. For more information, contact its Office of Academic Affairs at 609/292-2955.

Graduate Study at the University

GRADUATE SCHOOL– NEW BRUNSWICK

Graduate instruction at the university began in 1876 with courses at Rutgers College, which conferred its first doctor of philosophy degree in 1884. The college issued detailed regulations governing graduate degrees in 1912 and set up a separate graduate faculty in 1932. The Graduate School–New Brunswick was established in 1952. The expansion of graduate programs on the Newark and Camden campuses led to the formation of the Graduate School–Newark in 1974 and the Graduate School–Camden in 1981.

Seventeen units grant graduate degrees at the university. In addition to the three graduate schools mentioned above, there are schools offering graduate professional degrees in the arts; business; criminal justice; education; law; communication, information, and library studies; management and labor relations; planning and public policy; applied and professional psychology; and social work. The Graduate School–New Brunswick has faculties in the academic arts and sciences, as well as several professional fields. Together with the Graduate School–Newark, it is responsible for all philosophical degrees awarded by the university at the doctoral level. The school's enrollment of 3,600 students is distributed among 60 graduate programs, and its faculty comes from virtually all the university's academic divisions.

The traditional goal of undergraduate instruction is a liberal education in the arts and sciences, while the traditional goal of graduate instruction is an education that fosters creative research, criticism, and scholarship in a particular discipline. The two goals are complementary. Most members of the graduate faculty at the university teach both graduate and undergraduate courses and are as concerned with general education as with specialization. They know that a university is supposed to be an organization of men and women dedicated to bringing about advances in human knowledge. The measure of a university's success is the degree to which its faculty and students are able to enrich the life of human societies.

The size of the graduate community stems from the large number of departmental and interdepartmental programs offered. Yet, actual enrollment is limited. Thus, the school can provide small classes and seminars in most degree programs, which permits close association between students and faculty members and encourages independent study. The graduate school stresses flexible programs to meet diverse student needs. Students and faculty members are engaged in the common pursuit of learning, and the Graduate School–New Brunswick encourages their joint exploration without imposing rigid, mechanical requirements.

Graduate students who earn their degrees at the university leave with a rigorous grounding in their disciplines and possess markedly broader intellectual experience and agility than they had when they began their studies. They will go into careers in the professions, industry, business, museums, research institutions, or into college or university teaching or other work with enhanced leadership abilities. They will carry with them the potential to contribute value to their own lives and to the lives of others.

Other Graduate Study at the University

In addition to degree programs offered by the Graduate School–New Brunswick, the following divisions of the university provide postbaccalaureate programs in New Brunswick and Piscataway.

Edward J. Bloustein School of Planning and Public Policy. M.P.H. and D.P.H. degrees in public health are awarded. The school also offers an M.P.P. degree and an M.P.A.P. in public policy and an M.C.R.P. degree and an M.C.R.S. in urban planning and policy development. In addition, the school awards several joint degrees in public policy, urban planning and policy development, and urban studies and community health. These programs are described in the school's catalog.

Ernest Mario School of Pharmacy. The school offers the Pharm.D. degree.

Graduate School of Applied and Professional Psychology. The school offers the doctor of psychology (Psy.D.) degree in professional psychology, with specializations in clinical psychology, school psychology, and organizational psychology. It awards the master of psychology (Psy.M.) *en passant* to the doctorate.

Graduate School of Education. In educational psychology, the school offers Ed.M. and Ed.D. degrees in counseling psychology; educational statistics and measurement; learning, cognition, and development; and special education.

In the area of educational theory, policy, and administration, the school offers an Ed.M. degree in administration and supervision in elementary education; administration and supervision in secondary education; adult and continuing education; school business administration; social and philosophical foundations; and social studies education. Also offered are Ed.S. and Ed.D. degrees in educational administration and supervision and school business administration.

For teachers, the school offers Ed.M., Ed.S., and Ed.D. degrees in elementary/early childhood education and for instruction in English/language arts, languages, mathematics, and science. Finally, the school confers the same three degrees in literacy education.

Mason Gross School of the Arts. The school grants M.F.A. degrees in theater arts and visual arts and the M.M., D.M.A., and A.Dpl. degrees in music.

School of Communication, Information and Library Studies. The school offers an M.C.I.S. degree in communication and information studies and an M.L.S. degree in library and information science.

School of Management and Labor Relations. The school awards an M.H.R.M. degree in human resource management and an M.L.E.R. degree in labor and employment relations.

School of Social Work. M.S.W. degrees are offered in administration, policy, and planning, and in direct practice.

At Rutgers–Newark, programs are offered by the Graduate School–Newark, the Rutgers Business School: Graduate Programs–Newark, the School of Criminal Justice, and the School of Law–Newark. At Rutgers–Camden, programs are offered by the Graduate School–Camden, the School of Law–Camden, and the School of Business–Camden.

Each of the university's graduate-level schools publishes a catalog that is available upon request. More complete descriptions of the schools located in New Brunswick can be found under their respective program listings in this catalog.

LOCATION

New Brunswick, with a population of about 42,000, is located in central New Jersey at Exit 9 of the New Jersey Turnpike and along the New York–Philadelphia railroad line. It is approximately 33 miles from New York City, and frequent express bus and train services are available from a station near the College Avenue campus to central Manhattan. Princeton is 16 miles to the south, Philadelphia about 60 miles to the southwest, and Washington, D.C., fewer than 200 miles to the southwest. The libraries, theaters, concert halls, museums, galleries, research institutes, clubs, and other educational, cultural, and recreational resources of the New York–Philadelphia region are easily accessible to students. In addition, Rutgers attracts many distinguished visitors, lecturers, and performing artists not always available to less favorably situated institutions. Newark, the state's largest city, and Camden, which faces Philadelphia across the Delaware River, are characteristic northeastern American metropolitan centers. The university's Newark campus is about 20 miles from its New Brunswick/Piscataway campuses, and a few faculty members are engaged in activities at both locations. The distance between New Brunswick and Camden is about 55 miles, making interchanges between these campuses less frequent. Nevertheless, the faculty participating in New Brunswick/Piscataway programs does include members from Camden and Newark.

Degree Programs Available

Advanced degrees in the subjects listed below are conferred by the university upon recommendation of the faculty of the Graduate School–New Brunswick. Further information about areas of specialization in which degree programs are conducted may be found under the general subject headings in the Programs, Faculty, and Courses chapter.

Animal Sciences (M.S., Ph.D.)
Anthropology (M.A., Ph.D.)
Art History (M.A., Ph.D.)
Biochemistry (M.S., Ph.D.)
BioMaPS (Ph.D.)
Biomedical Engineering (M.S., Ph.D.)
Bioresource Engineering (M.S.)
Cell and Developmental Biology (M.S., Ph.D.)
Ceramic and Materials Science and Engineering (M.S., Ph.D.)
Chemical and Biochemical Engineering (M.S., Ph.D.)
Chemistry and Chemical Biology (M.S., M.S.T., Ph.D.)
Civil and Environmental Engineering (M.S., Ph.D.)
Classics (M.A., M.A.T., Ph.D.)
Communication, Information, and Library Studies (Ph.D.)
Comparative Literature (M.A., Ph.D.)
Computer Science (M.S., Ph.D.)
Ecology and Evolution (M.S., Ph.D.)
Economics (M.A., Ph.D.)
Education (Ph.D.)
Electrical and Computer Engineering (M.S., Ph.D.)
English, Literatures in (M.A., Ph.D.)
Entomology (M.S., Ph.D.)
Environmental Sciences (M.S., Ph.D.)
Food and Business Economics (M.S.)
Food Science (M.S., Ph.D.)
French (M.A., M.A.T., Ph.D.)
Geography (M.A., M.S., Ph.D.)
Geological Sciences (M.S., Ph.D.)
German (M.A., Ph.D.)
History (M.A., Ph.D.)
Industrial and Systems Engineering (M.S., Ph.D.)
Industrial Relations and Human Resources (Ph.D.)
Italian (M.A., M.A.T., Ph.D.)
Linguistics (M.A., Ph.D.)
Mathematics (M.S., Ph.D.)
Mechanical and Aerospace Engineering (M.S., Ph.D.)
Mechanics (M.S., Ph.D.)
Medicinal Chemistry (M.S., Ph.D.)
Microbiology and Molecular Genetics (M.S., Ph.D.)
Music (M.A., Ph.D.)
Neuroscience (M.S., Ph.D.)
Nutritional Sciences (M.S., Ph.D.)
Oceanography (M.S., Ph.D.)
Operations Research (M.S., Ph.D.)
Pharmaceutical Science (M.S., Ph.D.)
Pharmacology, Cellular and Molecular (M.S., Ph.D.)
Philosophy (M.A., Ph.D.)
Physics and Astronomy (M.S., M.S.T., Ph.D.)
Physiology and Integrative Biology (M.S., Ph.D.)
Plant Biology (M.S., Ph.D.)
Political Science (M.A., Ph.D.)
Psychology (M.S., Ph.D.)
Public Health (Ph.D.) (offered jointly with and administered by UMDNJ–School of Public Health)
Social Work (Ph.D.)
Sociology (M.A., Ph.D.)
Spanish (M.A., M.A.T., Ph.D.)
Statistics (M.S., Ph.D.)
Toxicology (M.S., Ph.D.)
Urban Planning and Policy Development (Ph.D.)
Women's and Gender Studies (M.A., Ph.D.)

SPECIAL PROGRAMS

Interdisciplinary Ph.D. Programs

In addition to the formal doctoral programs, special interdisciplinary Ph.D. programs may be arranged for students who wish to pursue subjects that cut across program boundaries. A student who seeks the Ph.D. in an area requiring the services of two or more program faculties should consult interested faculty members and then submit a formal proposal outlining a program of study to the dean of the Graduate School–New Brunswick. Courses, examinations, the dissertation topic, and the names of faculty members who have agreed to serve as the student's committee must have the approval of the directors of the graduate programs involved. Requests for special programs normally are considered only after the student has completed satisfactorily at least one year of work in the Graduate School–New Brunswick. Upon receiving written approval of the faculties concerned, the dean appoints an *ad hoc* committee to supervise the remainder of the student's program of graduate study and research. The university transfers the student to the interdisciplinary Ph.D. program (curriculum code 554).

Joint Programs

Rutgers, The State University of New Jersey, and the University of Medicine and Dentistry of New Jersey–Graduate School of Biomedical Sciences also offer joint Ph.D. and M.S. degrees to candidates in biochemistry, biomedical engineering, cell and developmental biology/anatomy, microbiology and molecular genetics, neuroscience, cellular and molecular pharmacology, physiology and integrative biology, and toxicology.

A joint doctoral program in public health is offered in cooperation with the University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School. This program is administered by UMDNJ–RWJMS. Students should address inquiries to the New Jersey Graduate Program in Public Health, Environmental and Occupational Health Sciences Institute, Rutgers, The State University of New Jersey, 170 Frelinghuysen Road, Piscataway, NJ 08854-8020.

Combined M.D./Ph.D. Degree

The University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School and the Graduate School–New Brunswick/University of Medicine and Dentistry of New Jersey–Graduate School of Biomedical Sciences offer a combined M.D./Ph.D. program.

Students will be selected for the program on the basis of previous academic work, MCAT or GRE test scores, and letters of recommendation.

For further information and an application form, contact the Graduate School of Biomedical Sciences, University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School, 675 Hoes Lane, Piscataway, NJ 08854-5635.

Simultaneous Degrees

Astudent admitted to one degree program may pursue simultaneously a second degree in another program. The director of the graduate program offering the second degree must notify the Office of the Dean of the Graduate School in writing of the student's acceptance by that program. Students may be registered in only one program at a time.

Certificate Programs and Core Curricula

The Graduate School–New Brunswick offers programs of concentration that complement formal degree programs. While these programs do not offer degrees, they do permit students to pursue interdisciplinary specializations without impeding their progress toward their degrees. There are several options for specialization. Some are done without formal acknowledgment, such as the program in packaging science and engineering. Others, however, are extensions of existing degree programs, such as the museum studies certificate offered in connection with the M.A. degree in art history. Programs leading to an interdisciplinary Ph.D. also may be arranged (see the section on Interdisciplinary Ph.D. Programs).

Interdisciplinary certificate programs and core curricula provide a more formal means for participating in a cross-disciplinary area and for encouraging collaborative work. Students who complete their degrees while also meeting the requirements of a certificate program will receive a certificate indicating their concentration of study. All certificate options require students to take courses outside their degree programs and to write a major paper or thesis on a topic appropriate to the certificate. Some programs also offer interdisciplinary seminars.

Core curricula are designed differently. In contrast to the informal structure that prevails in certificate programs, students must apply formally and receive admission into core curricula. Typically, these programs provide fellowship or traineeship support for enrolled students. Basic courses, seminars, and laboratory rotations allow students to explore problems at the boundaries of degree programs and to postpone commitment to a given degree program for a time. Students completing such curricula also must meet the requirements of the degree program in which they are matriculated.

Details concerning certificate programs and core curricula may be found in the Programs, Faculty, and Courses chapter.

Certificate Programs	*Core Curricula*
Alcohol Studies	Biotechnology
African Studies	Molecular and Cell Biology
Asian Studies	Molecular Biophysics
Cognitive Science	Molecular Biosciences
Curatorial Studies	
Engineering Geophysics	
Geospatial Information Science	
Historic Preservation	
Human Dimensions of	
Environmental Change	
Medieval Studies	
Quaternary Studies	
Russian, Central and	
East European Studies	
Teaching of Writing	
Wireless Communications	
Women's and Gender Studies	

Nondegree Graduate Study

The Nondegree Graduate Study Office, 18 Bishop Place (732/932-7711), cooperates with the Graduate School–New Brunswick in arranging the admission of part-time, nonmatriculated students. Nondegree graduate study is available at the discretion of the academic programs.

With the approval of the appropriate graduate program director, as many as 12 credits earned in courses successfully completed in the nondegree program may be applied to satisfy requirements for students subsequently admitted to degree programs. Admission to a nondegree program, however, is independent and distinct from admission to a degree program. Each requires a separate application and fee, and admission to nondegree study does not guarantee admission to a degree program. Students are not permitted to accumulate more than 12 credits in nondegree study prior to matriculation in a degree program. Students admitted to nondegree study must comply with the rules, regulations, and deadlines of the Graduate School–New Brunswick.

Admission

REQUIREMENTS

A bachelor's degree, or its equivalent, from a recognized institution of higher education is required of applicants to the Graduate School–New Brunswick. An average of *B* or better in previous academic work is expected. Additional evidence of potential for graduate study must be demonstrated by letters of recommendation and by scores on the Graduate Record Examination, which all programs require. Applicants should refer to the current application form and instructions for the specific requirements and prerequisites of each program. The applicant's character, integrity, and fitness to practice a particular profession also may be considered in the admissions process. Admission is competitive, and some applicants who meet or surpass minimum requirements may be denied acceptance. Admission is recommended by faculty of the graduate program that a student seeks to enter, and it must be approved by the dean of the Graduate School–New Brunswick or the dean's representative.

APPLICATIONS

Admission materials are available from the Office of Graduate and Professional Admissions, Rutgers, The State University of New Jersey, 18 Bishop Place, New Brunswick, NJ 08901-8530 (732/932-7711). These materials may be downloaded from the Graduate Admissions web site at *http://gradstudy.rutgers.edu,* and students can apply electronically from this site. A complete application consists of the application form, the application fee, letters of recommendation, official transcripts of previous academic work, a personal statement or essay, and test scores. Additional materials may be required by some programs. Detailed procedures and instructions accompany the application form.

DEADLINES

Application deadlines, which vary by program, are listed in current admissions materials. Applications for assistantships and fellowships that are received after March 1 are at a disadvantage, but they will be considered as long as awards are available. Many programs have established different financial-aid deadlines, which are cited in the application information. International students applying from abroad must submit application materials by November 1 for spring-term admission and by April 1 for fall-term admission, unless the individual program deadline is earlier. Programs reserve the right to change stated deadlines.

TESTS

The Graduate School–New Brunswick requires applicants for matriculated status to submit results of the General Graduate Record Examination (GRE). GRE information may be obtained from the Graduate Record Examination Program, Educational Testing Service, P.O. Box 6000, Princeton, NJ 08541-6000 (609/771-7670). Some programs also require additional tests.

Graduate programs may require that test scores more than five years old be validated, either by evidence of continued work in the field or by reexamination.

INTERNATIONAL APPLICANTS

International applicants are required to submit scores from the Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS) if English is not their native language. For information about the TOEFL, contact TOEFL/TSE Services, P.O. Box 6151, Princeton, NJ 08541-6151 (609/771-7100). For information about the IELTS, contact IELTS International, 1024 West Orange Grove Avenue, Arcadia, CA 91006 (626/355-0650). English proficiency is a prerequisite for graduate study at the university. Admitted students may be required to take a test of English proficiency soon after arrival at the university and may have to take course work in English as a Second Language (ESL). These courses are described in the Programs, Faculty, and Courses chapter.

New international students appointed as teaching assistants are required to take an oral proficiency test regardless of their TOEFL or IELTS scores. Nonimmigrant students also must present evidence of adequate financial resources to meet educational and living expenses.

NOTIFICATION OF DECISIONS

Applicants will receive written notification of admissions decisions from the Office of Graduate and Professional Admissions. Admission will be confirmed on a Certificate of Admission, which may list certain conditions. Such conditions should be satisfied before registration unless otherwise indicated. Admission to the Graduate School–New Brunswick does not constitute admission to candidacy for an advanced degree. Candidacy is explained elsewhere in this catalog.

Students who fail to register for the term to which they were admitted should contact the graduate admissions office for further instructions.

Tuition and Fees

FEE SCHEDULE

2003–2004 Academic Year

Note: The university reserves the right to alter the amounts indicated on the following schedule at any time before the first day of classes of a term.

Application Fee, nonrefundable	$ 50.00
Tuition *	
New Jersey resident, 12 credits per term	4,476.00
Non-New Jersey resident, 12 credits per term	6,562.50
New Jersey resident, per credit	373.00
Non-New Jersey resident, per credit	546.85
Student Fee, per term	
Full time (12 or more credits)	438.75
Part time (11 or fewer credits)	115.50
Off-campus college fee, full time	470.50
Off-campus college fee, part time	117.60
Matriculation continued or 1 credit of research	7.00
Computer Fee, per term	
Full time (12 or more credits)	100.00
International student	100.00
Other ($40.00–94.00 based on credit hours)	40.00+
Housing, per term †	
Dormitory, including breaks	2,728.00
Dormitory, calendar year	3,193.00
University apartments, including breaks	2,861.00
University apartments, calendar year	3,361.00
Meal Plans, per term	
Any 105 meals to any 285 meals	1,147.00–1,605.00
Any 50 meals to any 75 meals (commuter)	500.00–660.00
Miscellaneous Fees	
Basic health insurance program, per term	
part-time students only (optional) ‡	106.50
Major medical insurance plan, per term §	197.50
Spouse, per term	197.50
Each child, per term	197.50
Late registration fee	50.00
Late payment fee	125.00
Returned check fee	50.00
Returned check processing fee	10.00
Partial-payment fee	25.00
Late payment fee for partial payments	25.00
Microfilming of doctoral dissertation	55.00
Student ID fee	15.00
Restoral Fee	
Fee, per term	373.00
Maximum fees (through five terms)	1,865.00
(applies to certain students who allow their registration to lapse and wish to be restored to active status as degree candidates)	

Note: All breakage and damage to university property is charged for in full. The university is not responsible for loss by fire or theft of private property in its buildings.

STUDENT FEE AND OTHER CHARGES

The student fee covers use of student centers and health centers, membership in the Graduate Student Association, and certain administrative services. The relatively low fee charged to graduate students does not include the fee for intercollegiate athletics, which entitles undergraduates to discounted prices for tickets.

Special fees charged for some undergraduate courses also apply to graduate students enrolling in those courses. Fees of varying amounts, covering the cost of materials and breakage, are required in certain laboratory courses in the sciences.

TERM BILLS

Instructions for registration and payment of term bills are sent by mail to all students' home addresses for the first and second terms with due dates indicated. Students who do not receive a term bill by July 15 for the fall term and by December 5 for the spring term should notify their local student accounting office promptly.

It is the student's responsibility to obtain, complete, and return the term bill on time. Students who fail to do so are charged a late payment fee of $125. The student is responsible to pay all costs incurred by the university to collect any unpaid balance. This may include, but is not limited to, collection costs, litigation/attorneys fees, and court costs.

Payment of the term bill may be made in person, by mail, or via the web at *www.studentabc.rutgers.edu.* Checks or money orders are preferred and should be made payable to Rutgers, The State University of New Jersey. Cash should not be sent through the mail. Payment can also be made by Visa, MasterCard, or Discover credit cards. Transactions which are declined by the bank are considered unpaid and are returned to the student. Refunds of credit card payments will be processed with a check issued by Rutgers to the student.

Returned Checks

A service charge of $10 is assessed if a check presented in payment of fees is returned to the university as uncollectible. If collectible payment is not made before late payment deadlines, the applicable late payment fees also are charged.

TUITION PAYMENT PLANS

The university offers various monthly payment plan options in addition to the partial payment plan listed below. Visit the web site *www.studentabc.rutgers.edu* for further information and enrollment forms.

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* For an explanation of New Jersey residency status, see Student Residency for Tuition Purposes in the Academic Policies and Procedures chapter.
† Housing rates may be slightly higher or lower depending on whether it is single or double occupancy.
‡ Required for international students.
§ This insurance is optional.

PARTIAL PAYMENT PLAN

Students who are enrolled for at least 6 credits and have a net balance due of $200 or more may pay their bill in installments under the partial payment plan, as follows:

1. First payment: 50 percent of the net balance due plus a $25 nonrefundable partial payment fee payable on or before the date indicated on the term bill.
2. Second payment: 25 percent of the net balance due on or before September 15 for the fall term and on or before February 1 for the spring term.
3. Third payment: net balance due on or before October 15 for the fall term and on or before March 1 for the spring term.

Any student submitting a term bill after classes have begun for the term must make payment according to the following schedule:

1. First payment: 50 percent of net balance due plus a $25 nonrefundable partial payment fee.
2. Second payment: net balance due on or before October 15 for fall term and on or before March 1 for spring term.

Any subsequent installment not paid on time incurs a late fee of $25. The university reserves the right to increase the partial payment plan fee if deemed necessary.

REGISTRATION

Activation of Registration

A student's registration is activated through the proper submission of a term bill, accompanied by payment, or through an appropriate claim of financial aid. Activation of registration will not take place if there are "holds" placed on a student's records because of failure to meet outstanding obligations.

Termination of Registration

The university will exercise the right to terminate the registration of any student who has an outstanding financial obligation to the university, after sufficient notice has been given to the student. The university reserves the right to "hold" transcripts and diplomas as a result of nonpayment of obligations and to forward delinquent accounts to collection agencies and to levy a collection fee. "Holds" are removed upon satisfaction of the outstanding obligation. The terminated student may petition for reinstatement of

enrollment by satisfying the indebtedness to the university and paying a $50 reinstatement fee.

Cancellation of Registration

To cancel registration and obtain a full refund of tuition and fees, students must notify the registrar in writing prior to the first day of classes. A student whose registration is cancelled by the registrar will receive a full refund of tuition and fees, and prorated charges for room and board, if applicable. Notification of cancellation received on or after the first day of classes is treated, for billing purposes, as a withdrawal and a refund is made based on the general refund policy.

GENERAL REFUND POLICY

A student who voluntarily withdraws from all courses during the first six weeks of a term receives a partial reduction of tuition (and charges for room and board, if applicable) according to the week of withdrawal as follows:

First and second week:	80 percent
Third and fourth week:	60 percent
Fifth and sixth week:	40 percent

No reduction is granted after the sixth week of the term.

The effective date of withdrawal is the date on which a written statement of withdrawal is received by the registrar. Student fees are not refundable.

No reductions are granted after the tenth day of classes to students who withdraw from one or more courses, but who remain registered in others. If withdrawal from one or more courses amounts to complete withdrawal from a program, the provision for full withdrawal applies. A student cannot completely withdraw from classes using the student telephone or web registration systems.

Failure to attend class is not equivalent to a withdrawal, and a student will not receive an adjustment of charges unless a formal withdrawal is filed with and approved by the registrar, regardless of whether the student actually attended classes or took examinations.

SENIOR CITIZEN AUDIT PROGRAM

By action of the University Board of Governors, New Jersey senior citizens (age 62 and retired) may audit on a space available basis, without credit, any regular course taught at the university. For further information, contact the Office of Community Affairs at 732/932-7823.

Financial Aid

A majority of full-time graduate students at the university receive some financial aid. The amount of support each student receives depends, in part, upon the availability of funds. The level of support often is dependent upon the specific graduate program and the student's degree status. Aid ranges from loans to grants covering tuition charges to awards sufficient to pay all educational and most living expenses. The sources of support include university funds, federal and state government funds, corporate and individual bequests to the university, and grants from educational and scientific foundations.

MERIT-BASED FINANCIAL AID

Assistantships, Fellowships, Grants, and Scholarships

All applicants are considered automatically for university-based assistantships, fellowships, and scholarships. Inquiries should be addressed to the director of the graduate program to which the student has applied.

Students are encouraged to apply for externally funded fellowships as well. See the Nonuniversity Fellowships heading later in this chapter.

Assistantships Awarded by the University. The minimum beginning salary for teaching and graduate assistantships is $14,300 (2002–2003) for an academic year, although higher salaries may be offered by some departments.

Fellowship Awards. Fellowship Awards are made by the Graduate School–New Brunswick and other units to doctoral students of exceptional promise. The awards typically carry stipends of $15,000 to $21,500 plus tuition for varying periods of time.

Bevier and University Fellowships. Graduates of Rutgers, The State University of New Jersey, and postqualifying students already at the university may apply for Louis Bevier Fellowships and University Fellowships. Funds provided by the state and by the Louis Bevier Memorial Fund, respectively, support a limited number of fellowships that carry stipends of $13,000. The Louis Bevier Memorial Fund was established through the generosity of Dr. and Mrs. Ralph G. Wright in honor of the late Dean Bevier.

Ralph Johnson Bunche Distinguished Graduate Award. Established in 1979, this distinguished graduate award is named after Ralph Johnson Bunche, the African-American statesman, Nobel Peace laureate, and recipient of an honorary doctor of laws from Rutgers in 1949.

Bunche fellowships provide $15,000 plus tuition remission for as many as two years to exceptional, new, full-time students with backgrounds of substantial educational or social disadvantage.

Bunting-Cobb Graduate Residential Fellowship for Women in Mathematics, Science, and Engineering. Bunting-Cobb Graduate Fellowships for Women in Mathematics, Science, and Engineering are offered by Douglass College, the women's undergraduate unit of Rutgers, for women enrolled as full-time students in mathematics, science, and engineering programs in the Graduate School–New Brunswick. The award provides a two-year fellowship to women graduate students in mathematics, science, or engineering. Bunting-Cobb Graduate Fellows live in residence in the Bunting-Cobb Math and Science Hall at Douglass and serve as mentors to undergraduate women in mathematics, science, and engineering. The award includes a stipend and a single room with board for the academic year. Stipend and responsibilities are based upon the fellow's year in graduate study. Bunting-Cobb Fellows have the opportunity to be part of a unique program of support for women in math, science, and engineering. For more information, contact the Douglass Project for Rutgers Women in Math, Science, and Engineering, Douglass College, Rutgers, The State University of New Jersey, 50 Bishop Street, New Brunswick, NJ 08901-8558, or call 732/932-9197.

Diversity Advancement Program in Teaching and Research. Through referral from graduate program directors, the Diversity Advancement Program identifies individuals whose ethnicity, gender, or other characteristics make them unusual among students in their respective fields. Fellowships from various sources are allocated to encourage the enrollment of these students and thus diversify the graduate community. The fellowships awarded are comparable to those awarded through the schools and colleges.

Eagleton Institute of Politics Graduate Fellowship Program. The Eagleton Institute of Politics offers fellowships to graduate students who seek a hands-on understanding of politics. The Eagleton Fellowship Program provides students the opportunity to further their understanding of the practice of politics and public affairs and to connect their knowledge to their chosen department or school. Graduate students at all levels in disciplines at the graduate school and many of the professional schools at Rutgers are eligible. As the core of the one-year program, fellows enroll in the Eagleton Seminar in American Politics, which explores the politics of policymaking. Fourteen Eagleton Fellowships are awarded each year with stipends of $5,000 or $6,000; seven of them also provide tuition. Applications are due by March 1. For further information visit *www.eagleton.rutgers.edu.*

Eagleton Institute of Politics Henry J. Raimondo Legislative Fellowships. The Eagleton Institute of Politics offers eight Henry J. Raimondo Fellowships to graduate students who want to participate in state government. Graduate students at all levels in disciplines at the graduate school and many of the professional schools at Rutgers' three campuses are eligible. The one-year fellowship provides a stipend of approximately $8,500 plus significant tuition remission. Fellows begin the program with a 3-credit state legislative process course in the fall. In the spring, they complement their academic study with 15 hours a week of practical experience as interns in the legislature. Fellows enroll for 3 credits of independent study in their respective disciplines and work with a faculty member in their school or discipline to coordinate their legislative internship experience and their academic study. Applications are due by March 1. For further information visit *www.eagleton.rutgers.edu.*

Nonuniversity Fellowships. Some graduate students at the university receive fellowships funded by sources outside the university. A major source of funding is the National Science Foundation, which offers talented graduate students in the sciences significant funding to pursue their academic programs. Information and applications are available from the Fellowship Office, National Research Council, 2101 Constitution Avenue NW, Washington, DC 20418. Other sources of prestigious fellowships are the Mellon Fellowships in the Humanities, administered by the Woodrow Wilson National Fellowship Foundation; the Jacob Javits Fellowships, administered by the U.S. Department of Education; and the National Defense Science and Engineering Fellowships, sponsored by the U.S. Department of Defense. Students may wish to consult standard reference material for other sources of nonuniversity fellowships. Students already enrolled in the Graduate School may consult the chosen datebook maintained by the Office of the Dean.

Many national, state, and regional associations make special awards. Students should contact clubs; fraternal, religious, and national professional organizations; and local interest groups for possible aid through stipends and tuition credits. A student who receives any of these awards is required to notify the Office of Financial Aid.

Henry J. Raimondo Legislative Fellowships. The Eagleton Institute of Politics offers eight Henry J. Raimondo fellowships to graduate students on Rutgers' three campuses who want to participate in state government. The one-year fellowship provides a $7,500 stipend plus tuition and fees. Fellows begin the program with a 3-credit state legislative-process course. In the spring, they complement their academic study with 15 hours a week of practical experience as interns in the legislature. Fellows enroll for 3 credits of independent study in their respective disciplines and work with a faculty member in their school or discipline to coordinate their legislative internship experience and their academic study. Applications are due by April 1.

Robert White-Stevens Graduate Fellowship. The Robert White-Stevens Graduate Fellowship is named in memory of Dr. Robert White-Stevens, who was an agriculturist and former chairman of the Bureau of Conservation and Environmental Science. Dr. White also was the assistant director of the New Jersey Agricultural Experiment Station, a biology professor, and a faculty member of Cook College. The fellowship named for Dr. White supports an advanced doctoral student who is committed to alleviating world hunger by increasing the food supply through plant or animal research.

Other Fellowships and Scholarships. Each department continually seeks funds from outside agencies to help defray student expenses. Inquiries regarding the availability of such monies may be made through graduate program offices and advisers.

NEED-BASED FINANCIAL AID

Limited funds are available from grants, low-interest loans, and part-time employment. Application for such aid is made by completing the Free Application for Federal Student Aid (FAFSA). These forms are available from most college and university financial aid offices, as well as from Rutgers' Office of Financial Aid. All students are encouraged to apply for federal and other forms of financial aid. A description of each program follows.

How to Apply

All applicants must complete the Free Application for Federal Student Aid (FAFSA) annually and submit it to the federal processor at the address listed on the form's envelope. Students should submit their aid applications by March 15 if they are seeking aid for the following academic year. The forms are available at all Rutgers financial aid offices. To ensure full consideration for funds, students should file their FAFSA at the time they submit their admission application, but no later than March 15.

Letters announcing financial aid decisions are mailed to all students as soon as possible after admission. Awards are based on financial need and are limited by the March 15 priority filing date. Thus, there is a definite advantage to submitting an early, accurate, and complete application.

Counseling is available at the financial aid office to all students regardless of whether they qualify for financial aid. When comparing aid offers from Rutgers with those from other institutions, students should remember that costs often differ significantly from school to school. Therefore, the important thing to weigh is not the dollar value of a financial aid offer, but the difference between the total value of the financial aid package awarded by the institution and the cost of attending that institution.

Part-Time Students

Since financial need is determined by comparing a student's resources with the cost of attending school, most part-time students who have jobs do not demonstrate financial need.

The university has extremely limited financial aid funds for part-time students. All application procedures and deadlines applicable to full-time students apply to part-time students.

Grants

State Grant. Full-time graduate students, who are classified as New Jersey residents for tuition purposes and who demonstrate financial need, are eligible to receive a New Jersey State Grant. Amounts, which vary from $200 to $1,000 per year, are dependent upon available funds. Application is made by submitting a FAFSA. EOF grant recipients are not eligible.

Educational Opportunity Fund (EOF). New Jersey residents who are full-time students and who can demonstrate backgrounds of financial and academic hardship are eligible for EOF grants ranging from $200 to $2,650. Students who received EOF grants as undergraduates are presumed eligible if they fall below the maximum income parameters required for all recipients of this state grant. Graduate students who did not receive EOF grants as undergraduates, but feel that they come from backgrounds of financial hardship and wish to be considered, should write to the financial aid office for consideration. The grants are renewable for the duration of a student's degree work. The student must demonstrate continued eligibility and provide evidence of satisfactory academic progress. In addition, students must complete the FAFSA.

Loans

Federal Perkins Loans. Federal Perkins Loans are available to students who are enrolled in a minimum of 6 credits per term, who are citizens or permanent residents of the United States, and who demonstrate need through the FAFSA. Annual awards vary according to fund availability but cannot, by federal regulation, exceed $6,000. Federal regulation limits the maximum aggregate loan amount for graduate and professional students to $40,000, including National Direct Student and Perkins Loans borrowed as an undergraduate student.

Interest at the rate of 5 percent begins nine months after the borrower ceases to enroll in a minimum of 6 credits per term. It extends over a maximum repayment period of 10 years. Monthly payments of at least $40 are required. Deferral of repayment is permitted for certain kinds of federal service, and cancellation of loans is permitted for certain public service positions.

All first-time Federal Perkins Loan borrowers at Rutgers are required to attend an entrance interview to learn about their rights and responsibilities regarding the loan. In addition, Federal Perkins Loan recipients must attend an exit interview before graduation or upon withdrawal from school. Details and procedures regarding the repayment of the Federal Perkins Loan are sent to each student recipient by Rutgers, The State University of New Jersey; Office of Student Loans; Division of Student Accounting, Billing, Cashiering, and Collections; 65 Davidson Road; Piscataway, NJ 08854-8094.

William D. Ford Federal Direct Loans. Federal Direct Student Loans (Direct Loans) are available to students from the federal government to pay for educational costs. These loans eliminate the need for an outside lender, such as a bank. To be considered for a Direct Loan, students must complete the FAFSA. Subsequently, the award letter issued by Rutgers will list eligibility for the program. Money awarded to students will be credited directly to their accounts. Because Rutgers has chosen to participate in direct lending, *the university cannot accept any Federal Stafford applications from students or their lenders.* Since the U.S. Department of Education is the lender for the Federal Direct Loan Program, borrowers will send all loan repayments to the department, rather than to several lenders.

In general, to be eligible for a Direct Loan, a student must

- have a high school diploma or a General Education Development (GED) certificate or meet other standards set by the U.S. Department of Education,
- provide evidence of U.S. citizenship or be an eligible noncitizen,
- be enrolled at least half time per term and be making satisfactory academic progress,
- have a valid social security number,
- sign a statement of educational purpose,
- not be in default on prior loans or owe refunds to a federal grant program, and
- register with the U.S. Selective Service, if required.

In addition to these requirements, all first-time Federal Direct Loan borrowers must attend an entrance interview in order to learn about rights and responsibilities regarding the loan.

The aggregate limit for Federal Direct Loans, *including both subsidized and unsubsidized amounts,* is $138,500 for a graduate or professional student (including loans for undergraduate study).

Federal Direct Subsidized Loan. This loan is based on financial need. The government pays the interest on the loan while the student is attending school. The variable interest rate is adjusted each year. Effective July 1, 2001, the maximum rate for the Federal Direct Loan was 5.99 percent. Additionally, borrowers are charged an origination fee of 1.5 percent. Graduate students may borrow $8,500 per year. The total debt may not exceed $65,500, including loans for undergraduate years.

Federal Direct Unsubsidized Loan. This loan is *not* based on financial need, and all interest charges must be paid by the student. The interest rate is the same as that of the Federal Direct Subsidized Loan. Students may borrow as much as $18,500 per year, less any amount from the subsidized loan program. The total debt permitted for all subsidized and unsubsidized Direct Loans is $138,500.

Emergency Loans. Students having a financial emergency may apply for a university loan of as much as $300 (up to $500 in an extreme case). The simple interest rate is 3 percent. An emergency need must be demonstrated and funds must be available.

Students should contact their local financial aid office for additional information. If loans in excess of this amount are required, an appointment with a counselor is recommended. Students need not be recipients of financial aid or have filed a financial aid application to be considered for these loans.

Note: Quoted interest rates may change at any time. Subsequent program regulations may change the terms of eligibility and repayment.

Employment on Campus

Federal Work-Study Program (FWSP). Federal work-study employment may be offered as a self-help portion of the financial aid award. Application for this program is made by filing the FAFSA. On-campus jobs are available in many departments. Selection for a particular job is based on the applicant's skills, job availability, university needs, and student preference. In assigning students jobs, the program assumes a student will work between 6 and 20 hours a week during the fall and spring terms. For summer assignments, students may work as many as 35 hours a week.

Any change in work-study jobs must be made through the student employment/financial aid office. Off-campus employment is available through the Federal Work-Study Program. These jobs are paid community service positions in nonprofit agencies. No job assignments will be made until financial aid requirements are met.

Preceptorships and Residence Counselorships. Appointments as preceptors or counselors in the various undergraduate residence halls are available to a limited number of graduate students. Upon request, the offices of the deans of students will provide information about the duties required of preceptors and counselors. In addition, they will outline the benefits offered—such as room, board, and tuition grants—and discuss application procedures. Normally, applications for September appointments must be received before May 1.

Other University Employment. Any graduate student enrolled at the university may inquire with individual academic or administrative offices for available non-FWSP openings. All hiring decisions for non-FWSP jobs are made by the department.

Job Location and Development Program (JLD). The JLD Program is open to all students enrolled in the university. Most employment opportunities are located outside the university in local businesses. Information about jobs is available online at *http://studentwork.rutgers.edu.*

Other Financial Resources

Veterans Benefits. The United States Veterans Administration operates various education-assistance programs for eligible veterans, war orphans, surviving spouses or children of veterans killed while on duty with the Armed Forces, disabled veterans, dependents of a veteran with service-related total disability, and certain members of the selected reserve. Inquiries concerning eligibility may be directed to the Veterans Administration office in Newark, New Jersey (800/827-1000); the New Jersey Department of Military and Veterans Affairs in New Brunswick, New Jersey (732/937-6347); or to the veterans coordinator on each campus. For New Brunswick, the number is 732/445-3557.

Veterans and others mentioned above who plan to use veterans' education benefits should present the Veterans Administration Certificate of Eligibility Form(s) and/or discharge papers (certified copy of the DD214) when registering for courses. If applying for other financial aid with the university, veterans must report to the Office of Financial Aid that they will receive veterans' education benefits.

Veterans planning to train under Chapter 32 VEAP, Chapter 30 of the New (Montgomery) GI Bill of 1984, or Chapter 106 for Reservists are required by the university to pay cash for tuition, fees, books, and supplies, when due. Veterans, in turn, receive an allowance for each month of schooling based upon credits and the number of dependents.

No veteran may withdraw officially from a course (or courses) without prior approval from the academic services and/or dean of students offices. All withdrawals must be submitted in writing. The date of official withdrawal will be the determining date for changes in benefits. Failure to comply with the official school withdrawal procedure may affect both past and future benefits. Any change in schedule must also be reported to the campus Office of Veterans Affairs.

RESTRICTIONS ON FINANCIAL AID AND EMPLOYMENT

Ordinarily, graduate students may not simultaneously hold two different fellowships, assistantships, or other substantial forms of employment. Students who have been offered two different awards should inquire at the Office of the Graduate School–New Brunswick before accepting either. Students who hold assistantships, fellowships, or traineeships may not accept employment outside their academic department without the permission of the graduate director *and* the dean of the Graduate School–New Brunswick.

Graduate students who have received aid administered by the Office of Financial Aid must report to that office any change in income, such as scholarships, loans, gifts, assistantships, or other employment received subsequent to the original aid award.

Student Services

LIBRARIES

With holdings of over three million volumes, the Rutgers University Libraries rank among the nation's top research libraries. Comprised of 26 libraries, collections, and reading rooms located on Rutgers' campuses in Camden, Newark, and New Brunswick, and RU-Online, a digital library, the Libraries provide the resources and services necessary to support the university's mission of teaching, research, and service.

There are two large research libraries on the New Brunswick campuses: the Library of Science and Medicine, which houses the primary collections in behavioral, biological, earth, and pharmaceutical sciences, and engineering; and the Archibald S. Alexander Library, which provides extensive humanities and social sciences collections. The Mabel Smith Douglass Library supports undergraduate education and houses the primary collections for women's studies and the performing arts. The Kilmer Library is the primary business library in New Brunswick and provides support for undergraduate instruction. There also are several specialized libraries and collections in the New Brunswick area including Alcohol Studies, Art, Stephen and Lucy Chang Science Library, Chemistry, East Asian, Mathematical Sciences, Music, Physics, and Special Collections and University Archives.

The John Cotton Dana Library in Newark (which also houses the Institute of Jazz Studies) supports all undergraduate and graduate programs offered on the Newark campus with an emphasis on business, management, and nursing. The Robeson Library houses a broad liberal arts collection, which supports all undergraduate and graduate programs offered on the Camden campus. Law libraries also are located on both the Camden and Newark campuses and have separate policies and online catalogs.

There is a reading room for graduate students located in the Alexander Library. In addition to study space, the Graduate Reading Room includes the graduate reserve collection, a noncirculating collection of standard works in the social sciences and the humanities; locked carrels for students working on their dissertations; and computer facilities.

Of particular interest to faculty and graduate students is Rutgers' membership in the Research Libraries Group, a nationwide consortium that allows members of the university community access to the collections of the most distinguished research libraries in the country, including those at Berkeley, Stanford, Yale, and the New York Public Library. Through a shared database, there is access to most of the books and other materials that are available for interlibrary loan.

The Libraries provide numerous electronic resources to the Rutgers community. Library users can search IRIS, the online catalog, through the Libraries' web site at *http://www.libraries.rutgers.edu/.* IRIS identifies materials owned by Rutgers libraries in Camden, Newark, and New Brunswick, and contains records for most items acquired since 1972. Students, faculty, and staff also can access online a variety of electronic indexes and abstracts, full-text electronic journals, research guides, and library services. The Libraries provide hundreds of CD-ROM titles in addition to online resources.

Rutgers University students, faculty, staff, and alumni are entitled to borrow materials from any of the Rutgers University Libraries. The Rutgers Request Service and Interlibrary Loan Service allow library users to request books and journal articles located at distant Rutgers libraries or outside the university. The loan period for faculty, staff, and graduate students is one full term. All other borrowers, including undergraduate students, may keep materials for 28 days. All materials, regardless of loan period or borrower's privileges, are subject to recall.

Reference librarians are available at all of the major libraries to assist with research projects, classroom instruction, and research strategies. In addition to individual instruction at the reference desk, librarians also provide in-class teaching at instructors' requests. Members of the reference department are available to help with both computerized and noncomputerized reference searches. For a fee, librarians also provide specialized subject database searching.

The Libraries are committed to providing equal access to services and collections for all library patrons. Users with disabilities may request special services through the circulation or reference department in each library.

COMPUTER FACILITIES

Rutgers University Computing Services (RUCS) provides extensive centralized and decentralized computing and network services for students, faculty, and staff of all academic and administrative units of the university. In addition to the RUCS facilities, many departments and schools operate computing facilities of various types.

For instructional applications and general student use, a group of Sun computer systems, collectively called "eden," is available. Any registered student can create his or her own account on these systems. These systems run the UNIX operating system and provide electronic mail; access to the Rutgers University data communications network, RUNet; access to the Internet; applications software such as SAS and SPSS; and programming language compilers. Machine-readable data files are available for census data, social science data, and other areas.

For research applications, a second group of Sun computer systems with greater capacity is available.

Public computing facilities are located on each campus. These facilities include Apple Macintosh and DOS/Windows personal computers and X-terminals. All of the workstations in the hubs are connected to RUNet. Software is available for word processing, spreadsheets, desktop publishing, graphics, statistical analysis, and other applications.

For further information, call 732/445-2296 or write Rutgers University Computing Services, Information Center, Rutgers, The State University of New Jersey, 54 Joyce Kilmer Avenue, Piscataway, NJ 08854-8045.

TEACHING ASSISTANT PROJECT (TAP)

The Teaching Assistant Project (TAP) is designed to promote excellence in undergraduate and graduate education at Rutgers–New Brunswick through the professional development of teaching assistants. The four main components of this project are a preterm orientation, ongoing training during the term, discipline-specific training within each program, and written materials designed for TAs. The two major publications of TAP are the *Teaching Assistant Handbook*, a comprehensive introduction to the university and teaching, and *Tap Talk*, a newsletter that focuses on topics of interest to TAs. A dedicated telephone line, the TA HelpLine (932-11TA), provides daily assistance to TAs who have questions about teaching. The TA Project's web site, *http://taproject.rutgers.edu,* also provides extensive information for TAs about teaching at Rutgers. Videotaping equipment is available for TAs who wish to have a class videotaped to improve their teaching performance. TAP recognizes the dual role of TAs in the university and seeks to assist them in teaching on the college level while balancing their responsibilities as graduate students. Questions about TAP should be directed to the Office of the Dean, Graduate School–New Brunswick at 732/932-7747.

HOUSING

Attractive and comfortable residence facilities for graduate students are available in several campus locations in New Brunswick and Piscataway.

Single graduate students may reside in furnished residence halls located on the Douglass and College Avenue campuses, or in furnished apartments available on the Cook and Busch campuses. Graduate residence halls have shared bath and kitchen facilities. The graduate apartments house four students in single bedroom units with full kitchens and bathrooms.

Graduate families are housed in one- and two-bedroom unfurnished apartment units located on the Busch campus. These units are very popular, and a waiting list is maintained. Early application is recommended.

Single graduate students may select housing for a full calendar year or for the academic year. Summer housing also is available.

For additional information, call the Graduate Housing Office at 732/445-2215, email *uhousing@rci.rutgers.edu,* or visit the housing web site at *http://www.housing.rutgers.edu.* The Graduate Housing Office is located at 581 Taylor Road on the Busch campus.

DINING SERVICES

The Division of Dining Services operates and maintains 5 student dining facilities and 11 cash facilities.These include Brower Commons on the College Avenue campus, Busch Dining Hall and Davidson Commons on the Busch campus, Cooper and Neilson Dining Halls on the Cook–Douglass campus, and Tillett Dining Hall on the Livingston campus. Each facility offers hours to suit student dining needs.

Dining Services offers several different "block plans," which provide convenience and flexibility to fit personal lifestyle and dining habits. Students can take advantage of "all-you-can-eat dining," in which there is no limit on the number of meals they can enjoy each week. Students may even bring in 10 guests per term.

For additional information, visit Dining Services in Records Hall on the College Avenue campus, call 732/932-8041, or go to the Dining Services web site at *http://www.rci.rutgers.edu/~rudining.*

RUTGERS UNIVERSITY HEALTH SERVICES

Rutgers University Health Services provides comprehensive ambulatory health care and education for all full-time students and those part-time students who have paid the student health service and insurance fees.

During the fall and spring terms, three health centers provide services for students in the New Brunswick/Piscataway area. The Busch–Livingston Health Center, located at Hospital Road and Avenue E on the Livingston campus, is open Monday through Friday, from 8:30 A.M. to 5:00 P.M. The Hurtado Health Center, located at 11 Bishop Place on the College Avenue campus, is open seven days a week when classes are in session during the academic year (Monday through Friday, from 8:30 A.M. to 8:00 P.M.; Saturday and Sunday, from 10:00 A.M. to 4:00 P.M.). The Willets Health Center, located on Suydam Street on the Douglass campus, is open Monday through Friday, from 8:30 A.M. to 5:00 P.M. The Hurtado Health Center operates year-round. In the summer and during breaks, it is open Monday through Friday only, from 8:30 A.M. to 4:30 P.M.

Health centers are staffed by physicians, nurse practitioners, registered nurses, counselors, and educators. A wide range of services is provided, including general primary care, gynecology, mental health services, alcohol and substance abuse outpatient treatment programs, health education, immunizations, allergy desensitization injections, laboratory tests, physical examinations, and referrals. Surgical and critical medical conditions are referred to the student's personal physician, the proper specialist, or an outside hospital for treatment.

Pharmacy services are located at each health center and are open during the following hours in the fall and spring terms: Busch-Livingston Pharmacy, Monday through Friday, from 9:30 A.M. to 5:00 P.M.; Rutgers Pharmacy (Hurtado), Monday through Friday, from 9:30 A.M. to 5:30 P.M.; and Saturday, from 10:00 A.M. to 3:00 P.M. Willets pharmacy services are available, Monday through Friday, from 8:30 A.M. to 5:00 P.M. The Rutgers Pharmacy (Hurtado) operates year-round. In the summer and during breaks, it is open Monday through Friday only, from 9:00 A.M. to 1:00 P.M. and 2:00 P.M. to 4:30 P.M.

Rutgers University Health Services' Department of Health Education provides health education, leadership, and training experiences to help students build skills, learn about themselves and others, and take action to enhance community health.

The Rutgers University Health Services is accredited by the Joint Commission on Accreditation of Healthcare Organizations for meeting national standards of ambulatory health care delivery.

STUDENT HEALTH INSURANCE

All full-time students, by paying the student fee, and those part-time students who elect to pay the student health service and insurance fees, are insured for up to $5,000 in medical expenses brought about by illness or injury. This policy provides excess coverage over any other insurance plans. Students have the option to purchase a major medical policy sponsored by the university that provides more extensive coverage. Students also may purchase coverage for their spouse and children at additional cost. Any student not covered by individual or family policies should consider this more extensive coverage. Information and applications are available from the Office of Student Health Insurance, Hurtado Health Center, Rutgers, The State University of New Jersey, 11 Bishop Place, New Brunswick, NJ 08901-1180 (732/932-8285).

Compulsory International Student Insurance Fee

All students in F or J immigration status whose visa documents are issued by Rutgers are required to have both the basic and the major medical insurance coverages. The costs for insurance are charged to such students on their term bills. All accompanying family members (spouse and children) also must be insured. Insurance coverage for spouses and children must be purchased at the Center for International Faculty and Student Services, Rutgers, The State University of New Jersey, 180 College Avenue, New Brunswick, NJ 08901-8537 (732/932-7402).

SEXUAL ASSAULT SERVICES AND CRIME VICTIM ASSISTANCE

Sexual Assault Services and Crime Victim Assistance staff provide support and assistance to crime victims, survivors, and other members of the university community. Advocacy, crisis intervention, counseling, and referrals are available. Programs and services for students, faculty, and staff promote ways of reducing the risk of being a crime victim and the availability of resources and options should a crime occur. With a special emphasis on crimes of interpersonal violence, educational programs are available to the university community on issues concerning sexual assault, domestic/dating violence, stalking, and peer harassment.

For more information or to schedule an appointment or program, call 732/932-1181, visit the department web site at *http://www.rutgers.edu/SexualAssault,* or email the staff at *sascva@rci.rutgers.edu.* The office is located at 3 Bartlett Street on the College Avenue campus, New Brunswick, New Jersey.

COUNSELING SERVICE

University Career Services

The university provides a comprehensive career service for students enrolled in graduate and professional studies throughout New Brunswick. Graduate students concerned with career issues, career decisions, preparing résumés/vitae, developing interviewing skills, and conducting a job search are encouraged to take advantage of this service. Seminars, workshops, and special programs designed to meet the needs of students with advanced degrees are offered each term. Individual counseling is available by appointment.

Career libraries at three locations house resource materials to assist in the career development and job search process. These include career planning and development books; sample résumés/vitae; current job listings; employer directories; federal and state job information; company literature; testing information; and internship, fellowship, and grant information. A credentials service is available for students and alumni who wish to compile letters of recommendation for future use in applying for employment or advanced degree programs.

The career services office also sponsors an on-campus recruitment program. Through this program, three hundred to four hundred employers from business, industry, and government agencies are invited each year to come to the campus to interview qualified students.

For further information concerning career services at Rutgers, students should visit one of the career offices located at 61 Nichol Avenue on the Douglass campus (732/932-9742); 46 College Avenue and 56 College Avenue (732/932-7287), both on the College Avenue campus; or the Busch Campus Center (732/445-6127).

Counseling Centers

Psychological counseling for graduate students is available through the counseling centers staffed by the undergraduate colleges.

Appointments can be made by contacting the appropriate office: Cook College Counseling Center, Cook Campus Center (732/932-9150); Douglass College Psychological Services, Federation Hall (732/932-9070); Livingston College Counseling Center, Tillett Hall (732/445-4140); Rutgers College Counseling Center, 17 Senior Street (732/932-7884); and University College Office of Counseling, Miller Hall (732/932-8074). Only the Rutgers College center is open during Summer Session.

Students can choose the service that is most convenient. Services are free for students, and strict confidentiality is maintained. All centers are staffed primarily by clinical or counseling psychologists.

Each counseling center offers individual and group psychotherapy and sees couples for marital/relationship issues. Therapy groups specifically for graduate students are available at several of the counseling centers. Most counseling is short term. Referral is available to other agencies or private practice when ongoing psychotherapy is needed or desired.

Psychological services also are available through the psychiatrists at the Rutgers student health center (732/932-7827).

Peer Counseling Services

There are four telephone hotlines and/or drop-in services on campus that offer supportive and anonymous listening and talk, help with crises, and a wide range of referral information. Each is staffed primarily by undergraduate students with special training. They are open mostly on Sunday and weekday evenings, and their current hours are given on answering machines at each service. The services include Scarlet Listeners Counseling Service (formerly known as 56 Peer Counseling Service), located in Bishop House (third floor), College Avenue campus

(732/247-5555); Women's Support and Resource Center (focused on women's issues) (732/828-7273); Gatehouse Peer Counseling Hotline, Cook–Douglass campus (732/846-0957); and the Rutgers University Lesbian/Gay Alliance Hotline (focused on issues of interest to gays and lesbians) (732/932-7886).

Services for International Faculty and Students

The Center for International Faculty and Student Services, 180 College Avenue (732/932-7015, email: *ru_cifss@email. rutgers.edu,* web address *http://www.rci. rutgers.edu/~cifss)* coordinates services for the university's international students, scholars, and faculty. The center provides direct support in the following areas: U.S. immigration regulations and procedures; liaison to campus offices, community groups, and U.S. and foreign government agencies; and advice on nonimmigrant status, employment, medical care, adjustment to American life, cross-cultural differences, family concerns, financial planning, and other personal matters. In addition, the center sponsors programs of interest to the international community, including a comprehensive orientation, a community-based International Friendship Program that gives students the opportunity to get to know American families, informational and cross-cultural seminars, and a variety of support programs for students and their families.

To ensure personal contact, all international students are assigned an international student adviser at the center and are encouraged to establish and maintain a close working relationship with center staff throughout their stay at Rutgers.

Nonimmigrant students in F-1 or J-1 status must register with the center upon arrival in New Brunswick and inform the center of any change in their academic program, address, or enrollment status. All questions regarding one's status as a foreign student or exchange visitor in the United States are addressed to this office.

Services for Students with Disabilities

Students with disabilities on the New Brunswick campus of Rutgers University are entitled to the same benefits of the university's educational mission, the same quality of student life, and are subject to the same academic and procedural requirements as other students. Rutgers is committed to providing reasonable accommodations inside and outside the classroom to meet students' diverse needs. The university's services include special assistance in academic advising, scheduling or rescheduling classes in barrier-free buildings, on-campus transportation for students with permanent or temporary mobility disabilities, assistive devices and equipment, learning assistance, and communication with faculty regarding students' general or specific needs. Each school in New Brunswick has a designated coordinator of services to students with disabilities to assist students enrolled in their school. Students with disabilities also may contact the New Brunswick campus coordinator for students with disabilities at 3 Bartlett Street, College Avenue campus, Room 105 (732/932-1711) for more information. The New Brunswick campus coordinator is TDD-accessible through the Student Information and Assistance Center, located at 542 George Street (732/932-9090). Complaints or grievances regarding Rutgers' compliance with the Americans with Disabilities Act of 1990 may be directed to the Director of Compliance, Student Policy,

and Judicial Affairs, 3 Bartlett Street, College Avenue campus (732/932-7312, *cspc@rci.rutgers.edu).*

CAMPUS INFORMATION SERVICES

Rutgers Information and Referral Center

Rutgers Information and Referral Center, the gateway to Rutgers, can be reached by calling 732/932-INFO. Trained student information assistants offer answers about admission or campus life. The service is available Monday through Friday, from 8:30 A.M. to 8:30 P.M.; and Saturday and Sunday, from 10:00 A.M. to 4:00 P.M., during the academic year. The hours during the rest of the year are Monday through Friday, from 8:30 A.M. to 4:30 P.M. Twenty-four hour access to the information and referral service is available via email through "Ask Colonel Henry" at *http://colonelhenry.rutgers.edu.* Information about activities and events at Rutgers also is provided online at *http://www.acs.rutgers.edu/calendar.* The New Brunswick/Piscataway official student listserv has timely academic and student information. Every Tuesday during the term, a weekly bulletin of official notices is sent to the email account of each student on the New Brunswick/Piscataway campus. Students are responsible for taking appropriate action on information in these bulletins.

Off-Campus Housing Service

As part of Campus Information Services, the Off-Campus Housing Service is the information and referral center for off-campus renting and housing needs at the New Brunswick/Piscataway campus and can be reached by calling 732/932-7766, or via email at *ochs@cis.rutgers.edu.* The service is located at 542 George Street, at the corner of George Street and Seminary Place on the College Avenue campus, where trained staff can offer help with just about any topic regarding off-campus housing and living. All office information and listings are available 24 hours a day online. Maps, informational items, and staff assistance also are available. The Off-Campus Housing Service can assist students, faculty, and staff in finding information about available rentals and "for sale" properties in the area. Office information and listings are available 24 hours a day online.

The university community can visit the Off-Campus Housing Service web site at *http://ruoffcampus.rutgers.edu.* It contains a large database of available rentals, apartment complex information, landlord-tenant rights information, tips to finding housing and preventing problems, and forms for a variety of renting purposes.

RU-TV and the Rutgers INFO Channel

RU-TV Network is a 65 channel cable system, providing service to the Rutgers community. It is available in residence halls, student centers, libraries, and many other campus locations. Watch channel 3 for current Rutgers information, channel 8 for local Rutgers programming, and channel 30, RU-TV's premium movie service, for *RU at the Movies.* Complete programming information is available online at *http://rutv.rutgers.edu.*

The Rutgers INFO Channel, Channel 3 on the RU-TV network, is available on the New Brunswick/Piscataway

campus. The station, operated by Campus Information Services, provides 24 hour a day information about events, programs, activities, and services available to students. Members of the Rutgers community may request that information about activities, services, and events be displayed on the Rutgers INFO Channel. Visit *http://rutv.rutgers.edu/infochannel.html* for more information.

Historical Tours

Campus Information Services provides historical campus tours led by seasoned guides. Reservations are required. Special tours also may be scheduled. For more information, call 732/932-9342.

STUDENT ASSISTANCE

Since the personal welfare of students must be the concern of an academic community, redress of grievances for graduate students at the university is provided through a number of informal arrangements. Depending upon the subject at issue, students matriculated in the Graduate School–New Brunswick may approach their graduate director, the Office of the Dean of the Graduate School, or their departmental representative to the Graduate Student Association. In addition, many graduate programs have departmental student associations. Further information may be obtained from the Graduate Student Association at the Rutgers Student Center on College Avenue or from the Office of the Graduate School.

DAY CARE CENTERS

In New Brunswick, day care is available on the Cook, Douglass, and Livingston campuses. On the Cook campus, the Department of Nutritional Sciences runs a half-day preschool for three- and four-year olds, which is open during the academic year only. The fee is set for the academic year with limited scholarships available based upon financial need. For information, call 732/932-8895.

On the Douglass campus, the Department of Psychology runs the Douglass Psychology Child Study Center. This center offers full-time day care for children who are one through six years of age. Hours are from 7:30 A.M. to 6:00 P.M., Monday through Friday, year-round. Kindergarten is offered in two and one-half hour sessions, Monday through Friday, within the day. A summer camp program for school-aged children also is offered. The fee for care is based on the number of days. Different payment plans are available (weekly, monthly, and yearly). For information, call 732/932-8881.

The Rutgers-Livingston Day Care Center on the Livingston campus is a private, nonprofit center that offers a full-time developmental program for children two years of age through kindergarten age. Hours are 7:00 A.M. to 5:30 P.M., Monday through Friday, year-round. There are two fee rates: (1) set rate tuition and (2) reduced rate tuition based on family size and income. For an application form and information, call 732/445-8881.

All the day care services are heavily used and there is frequently a waiting list. Students should contact the centers early.

PARKING AND TRANSPORTATION

Any vehicle using campus parking facilities must be registered and must display a valid permit at all times. Fees for students vary according to their classification. Resident student vehicles are assigned in their specific residence lot only. Commuter student vehicles are assigned to a parking zone, according to college affiliation, on a particular campus only. Maps indicating resident and commuter student lots are available from the Department of Parking and Transportation Services, 26 Mine Street, College Avenue campus.

An intercampus bus transportation service is available to all Rutgers students, faculty, and staff. This bus service provides transportation within walking distance of all major campus areas and the major public transportation centers in New Brunswick. Schedules for the campus bus service are published each fall. Van transport is available for students with permanent disabilities who are unable to use campus buses to get to and from class. Requests for this service should be made through the office of the student's dean.

For more information, call 732/932-7744, email *parktran@rci.rutgers.edu,* or visit the Parking and Transportation web site at *http://parktran.rutgers.edu.*

Student parking for the Civic Square building is available at the New Street parking lot, which is located a few blocks away. An access card for the lot should be obtained from the Department of Parking and Transportation Services.

GRADUATE STUDENT ASSOCIATION

The Graduate Student Association (GSA), of which all graduate students are automatically members, sponsors a variety of social and cultural activities for graduate students and represents their interests to the university through its legislative body. The GSA provides free legal advice to students and it sponsors academic programs, films, mixers, trips to New York, and community action programs.

Every graduate student, full time or part time, in any of the eight New Brunswick graduate and professional schools automatically becomes a member of the GSA. A president, vice president, treasurer, and secretary are elected at large. The GSA's main legislative body is its Council, which meets once a month. Every graduate program and department may elect one representative for every 40 students enrolled; schools not organized into departments elect their representatives at large, one for every 40 students enrolled. (Departments with less than 40 students also are allowed one elected representative.) If you are interested in being a department representative, check with your departmental organization or the GSA office. The GSA offices are located in the Graduate Student Lounge (GSL) in the Rutgers Student Center on College Avenue in New Brunswick and may be contacted at 732/932-7995 (GSA) or 7994 (GSL).

Graduate student lounges, located in the Rutgers Student Center, Busch Campus Center, and Douglass College Center, are primarily for the use of graduate students and for the functions sponsored by and for graduate students. These provide a comfortable atmosphere for socializing, lounging, and studying.

PAUL ROBESON CULTURAL CENTER

The Paul Robeson Cultural Center, established in 1969, serves to document, preserve, and present the contributions of African peoples to world civilizations, with particular reference to the artistic, scientific, social, and political contributions of people of color in the Americas and New Jersey. The center provides leadership, vision, and support for the more than 40,000 people each year, including more than 5,000 African-American students at Rutgers, through cultural programs and educational opportunities that broaden their understanding and appreciation of the American diaspora. Further, the center works closely with the tiers of communities served by Rutgers in local, state, national, and international spheres.

The center is open Monday through Thursday, from 8:30 A.M. to midnight; Friday, from 8:30 A.M. to 9:00 P.M.; Saturday, from NOON to 8:00 P.M.; and Sunday, from 1:00 P.M. to 9:00 P.M. The center is located on Bartholomew Road, Busch campus, adjacent to the Busch Campus Center. For more information, call 732/445-3545.

CENTER FOR LATINO ARTS AND CULTURE

Opened in April 1992, the center's primary mission is to research, promote, document, and interpret Latino culture. The center identifies scholars, artists, and experts who help develop interdisciplinary programs that define and examine Latino culture, history, literature, and the arts. These programs, as well as special projects, are designed to foster academic excellence and advance the appreciation, growth, and well-being of the Latino cultural community.

The center builds a broader understanding of Latinos and their culture through conferences, exhibitions, lectures, theater productions, symposia, workshops, artists' forums, concerts, academic seminars, publications, and collaborative projects with community organizations outside the university.

Located at 122 College Avenue, the center is open weekdays from 9:00 A.M. to 5:00 P.M. For special events, the center also is open on weeknights and weekends. Please call 732/932-1263, 1494 for further information.

ASIAN AMERICAN CULTURAL CENTER

The Asian American Cultural Center started its operations in 2000. Through its activities and programs, the center documents and disseminates information about the artistic, scientific, social, and political contributions of Asians and Asian Americans, with a focus on expanding the multicultural and intercultural understanding of Rutgers University undergraduate students, and providing a supportive environment for Asian American students.

The center works closely with Asian American student organizations, and collaborates with Rutgers academic units and administrative offices as well as Asian American community-based organizations in the development of cultural programs, curriculum enrichment, and other activities for the entire Rutgers community.

The center, located at 103 A & B Tillett Hall on Livingston campus, is open weekdays from 8:30 A.M. to 4:30 P.M. For more information, call 732/445-8043 or visit *http://www.rci.rutgers.edu/~aacc.*

OFFICE OF DIVERSE COMMUNITY AFFAIRS AND LESBIAN-GAY CONCERNS

The Office of Diverse Community Affairs and Lesbian-Gay Concerns, established in the spring of 1992 as a resource for the campus community, provides coordination, assistance, information, educational activities, and public programs to staff, faculty, and students in the areas of lesbian-gay-bisexual-transgender awareness; the concerns of students with disabilities; and bias awareness, prevention, and intervention.

Undergraduate and graduate students interested in becoming involved in lesbian-gay-bisexual-transgender issues and programs; students with disabilities who wish to identify resources; and students who have experienced, witnessed, or are concerned about bias and intolerance on the basis of race, ethnicity, language, color, national origin, religion, sexual orientation, gender, and/or disability may contact the director of the office, Cheryl Clarke, at 3 Bartlett Street, College Avenue campus (732/932-1711) for assistance, advisement, counseling, and referral. Faculty, staff, and student groups who wish to obtain technical assistance, staff development, or in-service training in these areas also may contact the director.

The office is TDD-accessible by calling 732/932-8670.

ACTIVITIES

Athletic Facilities

The athletic facilities at Rutgers include several gymnasiums, swimming pools, tennis courts, baseball fields, and an 18-hole golf course. A fee is charged for the use of the golf course; graduate students otherwise are entitled to make use of these facilities without charge. Several of the athletic clubs in the undergraduate colleges—bowling, judo, lacrosse, rugby, skiing, and others—also are open to graduate students.

Athletic Ticket Policies

Tickets to intercollegiate football and basketball games are available at a special rate. All ticket information is available at the ticket office located in the Louis Brown Athletic Center.

Concerts, Dramatic Productions, and Lectures

Several series of concerts by world-famous musicians, bands, dancers, and musical organizations are presented on campus each year by the Office of University Arts Services, the departments of music and dance of the Mason Gross School of the Arts, the New Brunswick Programming Committee, the student center programming boards, and the concert organizations of the different campuses. Many events are free.

The Department of Theater Arts of the Mason Gross School of the Arts presents 15 to 18 productions a year at the Mason Gross Performing Arts Center on the Douglass campus. The Cabaret Theater Society and the College Avenue Players are student organizations that provide students who are not in the professional Mason Gross program with the opportunity to express their theatrical talents and

to broaden their acting experience.

Numerous lectures are presented regularly by academic departments, lecture series groups, and other organizations. Several concert series, movie series, and numerous lectures are sponsored at the university throughout the year.

ALUMNI

Alumni Relations

The university seeks the support of its alumni and, in return, offers them a number of services and programs. The responsibility for working with the university's entire alumni body, now numbering over 300,000, is vested in the Department of Alumni Relations. The department has two main objectives. First, it maintains contact with Rutgers alumni, informing them of the university's programs with the hope that they will assist Rutgers in fulfilling its educational goals. Second, the department encourages alumni to continue their college friendships after graduation through social, educational, and reunion activities.

All undergraduate colleges and most graduate and professional schools have their own alumni associations that sponsor programs based on the interests of the alumni of that college. Active membership is maintained through payment of regular alumni dues. Many alumni associations are represented in the Rutgers University Alumni Federation, which sponsors universitywide programs such as homecoming, distinguished alumni awards, legislative receptions, group travel, and insurance. The Department of Alumni Relations provides guidance and administrative services to each of the college associations, as well as to a network of regional alumni clubs throughout the country.

The university publishes an award-winning magazine for alumni and friends of the university.

The department's New Brunswick office is located at Winants Hall, 7 College Avenue, New Brunswick, NJ 08901-1262 (732/932-7061).

Rutgers University Foundation

The Rutgers University Foundation is the fund-raising arm of Rutgers, The State University of New Jersey. The Rutgers Foundation was incorporated in 1973 to support the uni-versity in obtaining private funds to meet important needs for which adequate monies may not be available from state, federal, or other sources. Scholarship and fellowship support for undergraduate and graduate students is essential, and academic programs seek the extra margin of excellence that only private giving can provide.

The professional staff of the Rutgers Foundation has helped the university's faculty, administration, and staff raise well over a half-billion dollars since its incorporation 29 years ago. Private fund-raising in the 2000–2001 fiscal year totaled $123,302,686, an all-time yearly high.

Rutgers is now embarked on a major universitywide campaign to raise $500 million by June 2004 and is well on its way toward reaching that goal. "The Rutgers Campaign: Creating the Future Today" is designed to advance Rutgers' academic growth as one of the nation's top public universities. The purposes of the campaign include attracting and supporting the best students, ensuring a superior academic program, advancing the quest for knowledge, recruiting and retaining top faculty, enriching the campus and community environments, and providing outstanding facilities and equipment.

The Rutgers Foundation staff provides information about the full range of giving opportunities to donors and prospective donors, including individuals, corporations, and foundations. The staff also cultivates donors and potential donors through a variety of activities, helps donors make sound choices on how to give and the designation choices available to them, and ensures that they are properly thanked for their gifts. Fund-raising officers are also based in many of the university's schools and colleges and work very closely with the foundation.

Persons interested in making contributions to any unit of the university or to Rutgers as a whole may do so by writing a check payable to the Rutgers University Foundation. The check should be accompanied by a brief note stating the designation of the donation and whom the gift is from. Checks should be mailed to: Accounting Department, Rutgers University Foundation, 7 College Avenue, New Brunswick, NJ 08901-1261.

More information about private giving to Rutgers may be obtained from the Rutgers University Foundation, Winants Hall, 7 College Avenue, New Brunswick, NJ 08901-1261 (732/932-7777).

Academic Policies and Procedures

STUDENT RESPONSIBILITY TO KEEP INFORMED

This catalog provides a summary of rules governing graduate work at the university, and students are advised to keep their copy as a reference handbook. Students are expected to familiarize themselves with the principal rules in this chapter and in the chapter on degree requirements. The academic and other regulations established by the faculty and administration of the Graduate School–New Brunswick and the Board of Governors of the university are subject to amendment at any time. Significant changes made after the publication of the catalog will be circulated to registered students by the Graduate School–New Brunswick. Exceptions to the rules can be made only through the dean's office.

In general, students should address their questions to their graduate program director. Questions related to general graduate student rules under jurisdiction of the Graduate School–New Brunswick also may be directed to the Office of the Dean, Rutgers, The State University of New Jersey, 25 Bishop Place, New Brunswick, NJ 08901-1181 (732/932-7034).

Graduate Student Mailing Address

Official communications among faculty, students, and staff members in the Graduate School–New Brunswick are delivered by campus mail to the mailboxes of each faculty member and student. In certain circumstances, however, official communications are mailed to the student's home address by U.S. mail. It is the student's responsibility to keep the registrar informed of a current mailing address. New students should consult with their graduate director about the most appropriate location for their first mailbox assignment. When other addresses are not significantly more convenient, students ordinarily assign themselves mailboxes at the offices of their graduate directors.

The Graduate School–New Brunswick also communicates with students through its electronic Listserv. In order to receive these messages, students must open a university computer account through RUCS as soon as they register.

REGISTRATION AND COURSE INFORMATION

A prepared registration form for each newly admitted student is made available to the student before the start of the fall and spring terms. Advising arrangements vary according to the needs of particular graduate offices, but the official registration and billing forms should be received by the student well before the first day of class. *It is the responsibility of the student to remain in communication with the Office of the Graduate Director.* The forms must be submitted by the student to the Office of the Graduate Registrar and must be received at that location by the announced deadlines. Overdue forms may require subsequent correspondence, entail additional fees, and necessitate reregistration. Forms may be returned by mail, but students should allow as many as 10 days for campus mail delivery; it is more prudent to deliver them by hand. Additions or changes of courses are routinely permitted during the first week of classes.

Registration in subsequent terms is made through the touchtone telephone registration system.

Once enrolled, students register early for subsequent terms. Registration instructions are distributed at that time. Changes of registration may be made at indicated times after early registration. In all other respects, the provisions of the above paragraph hold.

A student admitted into a degree program of the Graduate School–New Brunswick is expected to remain registered in every fall and spring term thereafter until he or she completes the program and earns the degree. Normally a student registers for courses or research; as appropriate, a student may also register for matriculation continued for a maximum of two terms. Any student who fails to maintain continuous registration may not resume formal graduate study or register again in the Graduate School–New Brunswick without first applying through the Office of the Graduate School for readmission. Master's degree students and doctoral students not yet admitted to candidacy may apply for readmission after one or two terms during which they were not registered. After two terms, they may be required to file a new application with the Office of Graduate and Professional Admissions.

Students who have been admitted to candidacy for the Ph.D. degree must apply for restoration of active status and pay a restoral fee. There is no time limit for readmission of such students.

Matriculation Continued

Students who must interrupt their studies may, with the approval of their graduate director, register for matriculation continued for a maximum of two consecutive terms. Matriculation continued also is the proper registration when there is no other appropriate registration category for a student. For example, students in many humanities and social sciences who have completed their formal course work and are preparing for examinations but are not registered for research would register for matriculation continued. There is no tuition fee for this registration, although a student fee is charged. This category of registration is not available to postqualifying doctoral students, who are expected to register for research in their fields until they have completed their degrees. Those students who are away from campus but working on their theses or dissertations and in contact with their committees are required to register for a minimum of 1 credit of research per term. Doctoral degree students who are on campus and engaged in research must register for a minimum of 3 credits per term. Master's degree students who are on campus and engaged in research must register for a minimum of 1 credit per term, for a maximum of three terms.

Summer Registration

The requirement of the Graduate School–New Brunswick that its students remain in continuous registration from the time they are admitted until their degrees are earned applies only to the regular academic year (spring and fall terms), not the Summer Session.

Summer Session registration forms and instructions are sent to each student with the fall-term registration instructions. Summer Session catalogs are available at the Summer Session office, 191 College Avenue, or at the registrar's office.

Change of Registration and Withdrawal

After the add-drop period ends, the only routinely permissible changes of registration are withdrawals from individual courses or withdrawal from *all* courses. Both actions are allowed without academic penalty until the end of the seventh week, and either may be accomplished with a form that is available from the Office of the Graduate Registrar and the Office of the Graduate School. The date on which the graduate registrar receives notice of withdrawal from the student governs the academic and financial consequences of the withdrawal. Students withdrawing from a course after the seventh week need the approval of the dean's office, are required to provide a letter indicating academic status in the course from the course instructor, and could receive failing grades at the discretion of the instructor. A student who stops attending a course without notifying the registrar will receive a grade of *F* in that course. No refunds of tuition are given for individual course withdrawals after the drop period ends. A student who withdraws from all courses may receive a partial refund, however, according to the rules described in the section on refunds in the Tuition and Fees chapter. Withdrawal of any sort is not permitted during the last two weeks of classes.

Transfer of Credit

Students may not transfer credits for courses taken at other institutions until they have completed at least 12 hours of graduate courses with a grade of *B* or better as a matriculated student at the Graduate School–New Brunswick. The courses being transferred must relate directly to a student's program of study at Rutgers, and the student must have received a grade of *B* or better in them. No credit may be transferred for thesis research work, course work done as independent study, or work in courses that were not graded. *P* or *S* grades are eligible for transfer if equivalent to a grade of *B* or better and accompanied by a letter of equivalency from the instructor of the course.

Permission is required to transfer credit for courses taken more than six years prior to the application for transfer of credit.

No more than the equivalent of one year of course work normally may be transferred toward the Ph.D. degree (i.e., 24 credits). No more than 40 percent of the credits required for a master's degree may be transferred from another institution.

Quarter credits will be converted to term credits by reducing the total by one-third.

For transfer of graduate courses taken as an undergraduate student, a letter is required from the registrar of the institution involved stating that the course or courses were not used toward an undergraduate degree. Applications for transfer of credit are available at the Office of the Graduate School.

Intercollege Registration

A student in the Graduate School–New Brunswick may apply to take a course offered by another division of the university by enrolling through the touchtone registration system or in person at the registrar's office. Other approvals may be required. Consult the Schedule of Classes. Students registering for courses in the University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School, in the New Brunswick Theological Seminary, or at Princeton University also must complete appropriate forms that are available from the Office of the Graduate Registrar.

Multiple School Registration

A student may not be registered simultaneously in two or more units of the university. Students wishing to take courses in more than one unit in the same term (or wishing to take courses in units in which they are not enrolled) may accomplish this through intercollege registration.

When a student makes multiple applications and is offered admission to more than one unit of the university, that student may register in only one. When a student has been admitted to a graduate and undergraduate unit, the registration will be in the graduate unit.

This policy is in no way intended to abridge a student's freedom to pursue simultaneously two degrees in two units. Such students must make special arrangements to keep both units informed of their academic progress, since they will be registered in only one unit.

Interuniversity Doctoral Consortium

The Graduate School–New Brunswick participates in the Interuniversity Doctoral Consortium, an arrangement among the eight major arts and sciences graduate schools in the New York metropolitan area that enables Ph.D. students in the arts and sciences to take courses offered by other consortium members through a simple interuniversity registration process. The other participating graduate schools are Columbia, Fordham, the Graduate Center of the City University of New York, New School University, New York University, Princeton, and the State University of New York at Stony Brook. Arts and sciences Ph.D. students in their second year of graduate study and beyond are eligible to apply through the graduate school dean's office.

Rutgers–Princeton Cooperative Exchange Program

Rutgers and Princeton universities have been engaged in an exchange program since 1964. This informal program does not require admission to or registration at the host institution. No funds are exchanged between the two institutions, and the student pays tuition only at the home institution. The policies and procedures related to this program stipulate that (1) participants must be matriculating, (2) exchange is limited to one or two graduate courses per term per student, and (3) the course must be part of the student's degree program and unavailable at the home institution. To participate, a Rutgers student must register for 16:001:816 Princeton Exchange (BA) (normally 3 credits) and have the forms (obtained from the Rutgers graduate registrar) signed by his or her adviser, dean, and Princeton course instructor. The forms are then submitted to the dean of the Graduate School, Princeton University. Princeton grades are assigned and are recorded on the student's record by using the above forms.

New Brunswick Theological Seminary and UMDNJ–RWJMS Exchanges

Cross-registrations are available in the New Brunswick Theological Seminary and the University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School. Forms are available at the Office of the Graduate Registrar.

Courses Taken "Not-for-Credit"

Students who wish to enroll in a graduate or a 100- through 400-level undergraduate course and perform all the assigned work without receiving credit may do so if they secure the advance approval of their advisers. When they register, they must indicate "not-for-credit" status by entering the symbol *N*. They must pay the normal graduate tuition fee for the course and fulfill the same requirements as other students during the term, including the execution of any written assignments. At the end of the term, however, they do not take the final examination, and they are assigned a grade of *S* (satisfactory) or *U* (unsatisfactory). The course and the letter grade are included on the student's record, but no credit toward a degree is given. See Grades and Records in this chapter for information regarding credit prefixes.

Auditing Courses without Registration

Upon obtaining the permission of the instructor of the course and subject to the availability of space, full-time students of the school may audit courses without registration. It is understood that no academic credit is earned in this manner. No official record is kept of audited courses.

Graduate Enrollment in Undergraduate Courses

Any course numbered 500 or above is designed for graduate students and normally carries credit toward one of the graduate degrees. Certain advanced undergraduate courses numbered in the 300s and 400s also may be approved for a given graduate student, either as a regular part of his or her graduate program or to remedy a deficiency in preparation. When a graduate student is permitted to enroll in a course numbered below 500, the credit prefix *E, G,* or *N* may appear on the registration and record forms. See Grades and Records later in this chapter for rules related to credit prefixes. No more than 12 credits of courses numbered between 300 and 499 may be offered in fulfilling the requirements for advanced degrees. (There are exceptions to this policy in the M.A.T. and M.S.T. programs.) Students registering in undergraduate courses are subject to the policies of the undergraduate division offering the course.

Undergraduate Enrollment in Graduate Courses

Qualified undergraduate students in the university who wish to study in courses offered by the graduate faculty are welcome to do so if they receive the written approval of the instructor offering the course and of the Graduate School–New Brunswick. Students must have senior standing and a cumulative grade-point average of at least 3.0. Forms are available in deans' offices for this purpose.

Minimum and Maximum Programs

The unit of credit used in Rutgers registration is based in part upon a measure of time, with 1 credit equal to one class hour a week through a 15-week term. For a 3-credit course, a qualified and competent student should require, on average, nine hours a week (in and out of classroom or lab) to carry out the work expected. One credit of laboratory requires three class hours of work per week. A full-time program is defined by the university as 9 credits a term. The maximum program is normally 15 credits, although under some circumstances registration for a maximum of 18 credits is permitted with approval of the dean. Fellows and assistants also must register their appointments according to directions provided by the registrar at the time of registration and submit form RT100 to the Office of Student Accounts.

Students with part-time employment outside the university who average 16 or more hours per week may not register for more than 9 credits per term, and students employed 30 or more hours per week may not register for more than 6 credits per term.

In interpreting conflicts about program limits, the dean's office generally regards 35 to 40 hours a week as a full-time commitment, whether in a nonuniversity job or a full-time student's program of study. The university assumes that the enthusiastic participant is apt to devote well above this amount of time, and that formal commitments of time become more difficult to make as they approach the upward limit of 18 credits.

Full- and Part-Time Students

For most purposes, a full-time student is defined as one who is registered for 9 or more credits. Anyone who registers for 8 or fewer credits is a part-time student. Graduate and teaching assistants who hold half-time (one-third line) academic appointments register their assistantships for 6 *E* credits (for which no tuition fee is to be paid). These 6 *E* credits, together with 3 credits of courses or research, qualify them as full-time students for official purposes. All courses, including both courses of research and regular courses undertaken "not-for-credit" (*E* and *N* prefixes), are counted in measuring the student's recordable program of work. These regulations govern student fees, statistical records, residence requirements, and other issues affected by definitions of full-time and part-time status. Some exceptions to the 9-credit rule may occur through arrangements with relevant administrative offices.

Change of Program

A change of curriculum within the Graduate School–New Brunswick requires the approval of the new graduate program director and the Graduate School–New Brunswick, and is not complete until notice of the approval change has been received from the Office of the Graduate School.

Change of Status

Students wishing to change their status within a graduate program, such as from nonmatriculated to matriculated or from master's to doctorate, should file the appropriate form with the Office of the Dean of the Graduate School.

Any student who has earned a terminal degree in the Graduate School–New Brunswick and who desires to continue as a nonmatriculated student should apply for a change of status. In this case, application must be made without any lapse in registration to avoid the need to apply for readmission. Foreign students must notify the Center for International Faculty and Student Services of a change in status.

Readmission or Restoration of Active Status

Students who have interrupted their graduate registration without receiving a degree in the program for which they were enrolled must apply for readmission. Appropriate forms are available from the Office of the Dean of the Graduate School–New Brunswick. Doctoral students who have passed their qualifying examinations are subject to a restoral fee of 1 credit of tuition at the current resident rate for each term missed (up to five terms). Students who have completed a master of philosophy degree at the university and have let their registration lapse are not subject to restoral fee payments for a period of up to four years.

All students, except candidates for the doctoral degree, who have interrupted their graduate registration must request readmission within two terms following their last registration. After this, the prospective student must submit a new application for admission to the Office of Graduate and Professional Admissions. (Applicants may request that previously submitted records be used.) The letters of recommendation should originate from faculty members at Rutgers with whom the student previously studied. In all other respects, including payment of the application fee and submission of official transcripts of all previous academic work, the application procedure is the same as the first application for admission.

CLASS SCHEDULES AND HOURS

Starting and closing dates for each term, scheduled holidays, and other important scheduling information can be found in the academic calendar. All class periods are 160 minutes in length, meeting once a week, unless otherwise specified. There will be 15 weeks of instructional activity for each course.

Attendance

All instructors are required to maintain an accurate record of attendance in each of their classes or sections. Students are expected to be present at each meeting of their classes. At the instructor's discretion, exceptions to this rule may be made for illness or other circumstances.

University examinations shall not be scheduled on Saturdays except in those courses that regularly meet on Saturday.

Absence Due to Religious Observance

It is the policy of the university to excuse without penalty students who are absent because of religious observances and to allow the makeup of work missed because of such absences. Examinations and special, required, out-of-class activities ordinarily will not be scheduled on those days when such students refrain from participating in secular activities. Absences for reasons of religious obligation will not be counted for reporting purposes. A student absent from an examination because of required religious observance will be given an opportunity to make up the examination without penalty.

Cancellation of Classes

It is the general policy of the university not to cancel classes because of inclement weather. However, because of the occasional hazards of night driving in the winter, exceptions may be made for evening classes, and under exceptionally hazardous conditions, exceptions may be made for daytime classes.

Announcements concerning campus status will be made over the following stations: WRNJ (1510 AM), WCTC (1450 AM), WCBS (880 AM), WINS (1010 AM), WKXW (101.5 FM), WRSU (88.7 FM), and NEWS12 (cable).

Additionally, information will be available through RU-TV's Rutgers Information Channel 3; the campus operating status page *http://nbp.rutgers.edu;* and from the Rutgers Information and Referral Center, *732/932-INFO*.

Arrangements for makeup work are announced by individual instructors.

GRADES AND RECORDS

In the Graduate School–New Brunswick, outstanding work is graded *A,* and good work is graded *B.* Some programs require students to achieve grades of *A* in at least half their courses to be accepted as serious candidates for the doctorate. The grade of *C* is for satisfactory work. The *B+* and *C+* grades are intermediate grades. The graduate faculty accepts for graduate credit only a limited number of courses in which a student earns a grade of *C+* or *C* (see the paragraphs on academic standing in the Degree Requirements chapter). A grade of *F* is assigned to students who fail to earn credit in a course they complete and to students who do not complete a course from which they have not withdrawn officially. The Graduate School–New Brunswick does *not* assign the grades of *D* or *D+* in its courses.

In addition, the Graduate School–New Brunswick uses the following grade symbols:

IN—(Incomplete). May be assigned at the discretion of an instructor who believes that an extension of time is warranted for a student whose work is incomplete at the end of the term. Incomplete work may be made up, and a change of grade may be authorized by the instructor, within any period agreed to by the instructor and the student. This makeup period may not extend for more than two terms beyond the original course registration (excluding Summer Session). Incompletes generated in a Summer Session must be completed by the end of the following Summer Session. Programs may establish shorter time limits. Students with two or more incompletes are not permitted to register for additional courses after one term until incompletes are completed.

Pass/No Credit. For certain specifically designated courses; applies to all students enrolled in those courses.

S/U—Satisfactory/Unsatisfactory. For 700-level courses of research carrying credit or in regular courses taken "not-for-credit" (*N* prefix).

W—(Withdrawal). Officially withdrew.

Credit Prefixes

The number of credits appearing on course records and registration cards may be preceded by a letter prefix as follows:

E. Course excluded from credit toward a degree; all course requirements must be completed and a regular grade is assigned.

G. A 300- or 400-level undergraduate course for which credit toward the graduate degree sought has been approved.

N. Course taken "not-for-credit." The final examination is not required. A final grade of *S* (satisfactory) or *U* (unsatisfactory) is assigned.

Graduate students registering for undergraduate courses are subject to the credit prefix rules of the undergraduate division offering the course.

Transcripts

Requests for official transcripts should be addressed to Records and Transcripts, Administrative Services Building, Room 200L, Rutgers, The State University of New Jersey, Office of the Registrar, 65 Davidson Road, Piscataway, NJ 08854-8096. The request should indicate that the student was enrolled in the Graduate School–New Brunswick, identify the dates of attendance, and give any other relevant information. It must be received at least 10 working days before the date the transcript is desired. Forms for making the request may be obtained from the recorder.

Student Identification Cards

New graduate students admitted for the fall term should visit the RUconnection Card Office during the summer months to be photographed for student identification cards. Instructions for students not photographed by the beginning of the term will be provided by the office. For the spring term, new graduate students should visit the office before the term starts. The RUconnection Card Office is located at the Busch Campus Center. Information on hours of operation, card benefits, and replacing lost or stolen cards may be obtained at the RUconnection web site address, *http://www.rci.rutgers.edu/~ruconxn,* or by telephone at 732/445-6949.

ACADEMIC STANDING

Student Review

Each program is expected to have established procedures for monitoring annually the progress of all students registered in the program. Each doctoral program has a formal programwide procedure to review students who have completed the equivalent of approximately one year of full-time study and to decide whether they may continue toward the doctorate. This procedure may be linked to the master's degree or to the qualifying examination, or may be independent of either. In no case should it be postponed beyond the equivalent of one and one half years of full-time study toward the degree. In connection with this procedure, faculty in a position to comment on the student's performance and progress are asked to do so by the graduate director or a designate. In conducting its review, the program will not limit its choice of faculty members to any list submitted by the student for recommendations.

Termination of Studies

Students may be required to terminate their graduate studies and withdraw from the Graduate School–New Brunswick if they fail to maintain satisfactory academic or professional standards in any phase of their graduate programs. Conditions imposed at the time of admission must be satisfied by each student. Nonadherence to the schedule of Time Limits for Degrees may constitute a basis for termination. (See the Degree Requirements chapter.)

When such problems occur, the program notifies the student *in writing* of the program's concern about the student's performance. Such a warning specifies the source of the concern, the applicable program or graduate school rules, and the proposed action. Warnings specify when and on what basis a recommendation for academic dismissal will be considered by the faculty. A probationary period of one term is normal.

Following the probationary period, a student who fails to meet the provisions of the warning is considered for dismissal by the faculty. A faculty vote is recorded on any motion to recommend dismissal, and a letter is written to the student stating the faculty action and its rationale.

When termination is recommended, the graduate program director communicates to the dean of the Graduate School–New Brunswick in writing the specific reasons involved, all warnings communicated to the student, the faculty procedures and actions leading to the recommendation, the recorded faculty vote for dismissal, and the mailing address of the student. The dean of the Graduate School–New Brunswick will write the actual letter of termination to the student. Subsequently, the student's transcript will bear the notation, "Academic Dismissal."

Due Process

Students are entitled to fairness in the way their academic performances are assessed. Each program has a statement that spells out how a student's academic progress is monitored and how comprehensive, qualifying, and final examinations are graded. Each program also has a procedure for academic appeals. The Graduate School–New Brunswick provides a further opportunity for appeal for students who wish to proceed beyond the program level (see below).

All students in the Graduate School–New Brunswick are entitled to expect that regularly scheduled examinations will be graded and grades announced within two weeks of completion of those examinations by the students. If a student fails a comprehensive, qualifying, or final (defense) examination, he or she is entitled to an explanation of the reasons for that decision.

Student Academic Appeals

Whenever possible, student academic appeals are handled within the graduate-degree program. The student should take the issue to the director of the graduate program or a designate for review and mediation. The director, or a designate, consults with all parties and proposes a resolution. If this is unsuccessful, the matter is referred to a faculty committee, as designated in the bylaws of the program. The committee may consult anyone it chooses in arriving at a recommendation in the matter. In extraordinary cases, it may ask third parties in the faculty to review the decision that was appealed.

While action within the faculty normally is final, a student may appeal to the Graduate School–New Brunswick if he or she feels the decision was unfair. Each case will be reviewed by a representative of the dean of the Graduate School–New Brunswick, who attempts to resolve informally the dispute. Should the issue remain unresolved, the student is notified in writing that he or she may request that the dispute be brought to the Appeals Committee. Such a request must be made within 30 days of notification. The Appeals Committee is comprised of four members of the elected Committee on Rules of Procedure named by the dean at the beginning of each academic year.

This committee hears appeals that have not been resolved by the Office of the Graduate School. The student must make his or her case in writing. A written response to the student's statement will be solicited from the director of the degree program whose action is being appealed. The committee normally bases its judgment on written submissions only. Should the committee deem it necessary, it may call upon the student and/or a faculty member or members for written or oral responses to questions raised by the committee.

A student may request an appearance before the committee. If they believe an appearance is warranted by unusual circumstances, the committee members may allow the student to appear before them. They may, however, limit the amount of time granted, which normally will not exceed 30 minutes. The committee reports its recommendations to the dean of the Graduate School–New Brunswick, whose decision is final.

Student Complaints about Grades

Students who wish to file a complaint about a course grade or a grade received for a particular piece of work in a course should first attempt to resolve the matter through discussion with the instructor. If the issue cannot be resolved satisfactorily between student and instructor, the student may specify in writing the basis for the complaint and request a review by the director of the graduate program offering the course. A written complaint about a grade for work completed while the course is in progress must be submitted to the program director no later than two weeks after notification of the grade. A student must submit a written complaint about a final course grade with the program director no later than four weeks after the postmarked date of the official notification of grades.

A student who wishes to appeal the decision of the graduate program must appeal in writing to the Office of the Dean. Written notification of the action taken by either the graduate director or the dean is sent to the student within four weeks of the filing of the appeal, excluding those weeks in which classes are not in regular session.

Holds

The privileges of registration, advance registration, receipt of a diploma at commencement, and receipt of transcripts of record are barred to students who have outstanding obligations to the university. Obligations may take the form of unpaid monies, unreturned or damaged books and equipment, parking fines, other charges for which a student may become legally indebted to the university, and failure to comply with disciplinary sanctions or administrative actions.

University departments and offices may place "holds" on registration, diplomas, and transcripts for any students having an outstanding obligation.

POLICY ON ACADEMIC INTEGRITY SUMMARY

"Academic freedom is a fundamental right in any institution of higher learning. Honesty and integrity are necessary preconditions to this freedom. Academic integrity requires that all academic work be wholly the product of an identified individual or individuals. Joint efforts are legitimate only when the assistance of others is explicitly acknowledged.

Ethical conduct is the obligation of every member of the university community, and breaches of academic integrity constitute serious offenses" (Academic Integrity Policy, p. 1).

The principles of academic integrity entail simple standards of honesty and truth. Each member of the university has a responsibility to uphold the standards of the community and to take action when others violate them.

Faculty members have an obligation to educate students to the standards of academic integrity and to report violations of these standards to the appropriate deans.

Students are responsible for knowing what the standards are and for adhering to them. Students also should bring any violations of which they are aware to the attention of their instructors.

Violations of Academic Integrity

Any involvement with cheating, the fabrication or invention of information used in an academic exercise, plagiarism, facilitating academic dishonesty, or denying others access to information or material may result in disciplinary action being taken at either the college or university level. Breaches of academic integrity can result in serious consequences ranging from reprimand to expulsion.

Violations of academic integrity are classified into four categories based on the level of seriousness of the behaviors. Brief descriptions are provided below. This is a general description and is not to be considered as all-inclusive.

Level One Violations

These violations may occur because of ignorance or inexperience on the part of the person(s) committing the violation and ordinarily *involve a very minor portion of the course work.*

Examples: Improper footnoting or unauthorized assistance on academic work.

Recommended Sanctions: Makeup assignment.

Level Two Violations

Level two violations involve incidents of a more serious nature and affect a more significant aspect or portion of the course.

Examples: Quoting directly or paraphrasing without proper acknowledgment on a moderate portion of the assignment; failure to acknowledge all sources of information and contributors who helped with an assignment.

Recommended Sanctions: Probation, a failing grade on the assignment, or a failing grade in the course.

Level Three Violations

Level three offenses involve dishonesty on a significant portion of course work, such as a major paper, an hourly, or a final examination. Violations that are premeditated or involve repeat offenses of level one or level two are considered level three violations.

Examples: Copying from or giving others assistance on an hourly or final examination, plagiarizing major portions of an assignment, using forbidden material on an hourly or final examination, using a purchased term paper, presenting the work of another as one's own, altering a graded examination for the purposes of regrading.

Recommended Sanctions: Suspension from the university for one or more terms, with a notation of "academic disciplinary suspension" placed on a student's transcript for the period of suspension, and a failing grade in the course.

Level Four Violations

Level four violations are the most serious breaches of academic integrity, and also include repeat offenses of level three violations.

Examples: Forgery of grade change forms; theft of examinations; having a substitute take an examination; dishonesty relating to senior thesis, master's thesis, or doctoral dissertation; sabotaging another's work; the violation of the ethical code of a profession; or all infractions committed after return from suspension for a previous violation.

Recommended Sanctions: Expulsion from the university and a permanent notation on the student's transcript.

Faculty members who believe that violations have occurred should immediately contact the Office of the Dean. Students who suspect that other students are involved in actions of academic dishonesty should speak to the instructor of the course. Questions on reporting procedures may be directed to the Office of the Dean.

UNIVERSITY CODE OF STUDENT CONDUCT SUMMARY

A university in a free society must be devoted to the pursuit of truth and knowledge through reason and open communica - tion among its members. Its rules should be conceived for the purpose of furthering and protecting the rights of all mem - bers of the university community in achieving these ends.

All members of the Rutgers University community are expected to behave in an ethical and moral fashion, respecting the human dignity of all members of the community and resisting behavior that may cause danger or harm to others through violence, theft, or bigotry. All members of the Rutgers University community are expected to adhere to the civil and criminal laws of the local community, state, and nation, and to regulations promulgated by the university. All members of the Rutgers University community are expected to observe established standards of scholarship and academic freedom by respecting the intellectual property of others and by honoring the right of all students to pursue their education in an environment free from harassment and intimidation.

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Preamble
University Code of Student Conduct

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Overview

Communities establish standards in order to ensure that they are able to fulfill their mission and keep their members from harm. The University Code of Student Conduct (referred to as "the code" in the remainder of this summary) defines those kinds of behavior that violate the standards of the Rutgers University community and also provides the mechanism for addressing alleged violations. In doing so, the code protects the rights of those accused of offenses (referred to as "respondents" in the remainder of this summary) by providing due process while also protecting victims of those offenses and the university community as a whole.

Process

The following summary presents key aspects of the code. Students should consult the code itself for complete information on each point.

Filing a Complaint

Any individual may file a complaint against a student suspected of violating the code by notifying the dean of students (or equivalent) of the respondent's college or school, or the assistant director of judicial affairs in the Office of Compliance, Student Policy, and Judicial Affairs.

Preliminary Review

Upon receipt of a complaint, a preliminary review is conducted by the dean of students (or equivalent) or his or her designee to assess the evidence and determine if it is sufficient to proceed to a hearing. The dean conducting this review also assesses the seriousness of the charges. The most serious charges can, upon a finding of responsibility, result in separation from the university (suspension or expulsion). These serious cases are decided at university hearings. Less serious offenses (nonseparable offenses) are heard according to procedures in place at the student's college or school.

Separable Offenses

The following offenses are deemed serious enough to result potentially in separation from the university should a student be found responsible at a hearing:

1. violations of academic integrity
2. forgery, unauthorized alteration or unauthorized use of any university documents or records or any instrument or form of identification
3. intentionally furnishing false information to the university or intentionally initiating or causing to be initiated any false report, warning, or threat of fire, explosion, or other emergency
4. use of force against any person or property or the threat of such force
5. sexual assault or nonconsensual sexual contact
6. hazing
7. violation of the university's Student Life Policy against Verbal Assault, Defamation, and Harassment (Copies are available from the judicial affairs office or dean of students' office.)
8. unauthorized entry into, unauthorized use of, or misuse of university property, including computers and data and voice communication networks
9. intentionally or recklessly endangering the welfare of any individual or intentionally or recklessly interfering with any university activity or university-sponsored activity
10. use, possession, or storage of any weapon, dangerous chemical, fireworks, or explosive, whether or not a federal or state license to possess the same has been issued to the possessor
11. the distribution of alcohol, narcotics, or dangerous drugs on university property or among members of the university community, if such distribution is illegal, or the possession of a sufficiently large quantity as to indicate an intention to distribute illegally
12. theft of university services or theft of, or intentional or reckless damage to, university property or property in the possession of, or owned by, a member of the university community, including the knowing possession of stolen property (Intentional or reckless misuse of fire safety equipment is regarded as damage under this section of the code.)
13. the violation of the ethical code of one's intended profession either by graduate students enrolled in any of the university's professional or graduate schools or by

undergraduate students in clinical courses or settings related to their intended profession

14. violations of federal, state, or local law where such violations have an adverse effect on the educational mission of the university

15. failure to comply with the lawful directions of university officials, including campus police officers acting in performance of their duties

16. knowingly providing false testimony or evidence; disruption or interference with the orderly conduct of a disciplinary conference or hearing; violating the terms of any disciplinary sanction imposed in accordance with this code; or any other abuse of the university's disciplinary procedures

Campus Advisers

Both complainants and respondents may select a campus adviser to assist them during the disciplinary process. Campus advisers may fully represent students, including speaking on their behalf. The Office of Compliance, Student Policy, and Judicial Affairs maintains a list of trained campus advisers for this purpose. Students are free to select any members of the university community to serve as their advisers, whether they are on the list or not.

Attorneys

Complainants and respondents also may, at their own expense, seek the advice of an attorney in addition to that of a campus adviser. Attorneys are free to advise students, to assist in the preparation of their cases, and to attend hearings, but may not speak on behalf of their clients or question witnesses at a hearing.

University Hearings

University hearings are presided over by a hearing officer and heard by a hearing board usually composed of three students and two faculty members. It is the hearing board's responsibility to determine whether the accused student is responsible or not responsible for violating the code. If the hearing board determines a student to be responsible by the standard of clear and convincing evidence, it also recommends a sanction for the offense to the vice president for student affairs. The vice president for student affairs considers the hearing board recommendation and determines the sanction.

Appeals

A student found responsible for violating the code may appeal the finding, the sanction, or both. Appeals are filed through the Office of Compliance, Student Policy, and Judicial Affairs, which forwards them to the Appeals Committee of the appropriate campus (Camden, Newark, New Brunswick).

Authority for Student Discipline

Ultimate authority for student discipline is vested with the Board of Governors of Rutgers, The State University of New Jersey. This authority has been delegated to university administrators, faculty, students, committees, and organizations as set forth in the University Code of Student Conduct. The above summary is intended to present some key facts of the code. Copies of the code are available from all deans of students' offices and have been placed at the reference desks of all university libraries. In addition, the assistant director of judicial affairs in the Office of Compliance, Student Policy, and Judicial Affairs will provide copies of the code upon request and is available to answer any questions about the code or related judicial matters.

UNIVERSITY SAFETY AND SECURITY

Division of Public Safety

Providing a safe and secure environment for all members of the university community is the highest priority of the university's public safety staff. The executive director for public safety is responsible for safety and security services on the New Brunswick/Piscataway campuses. On the Newark and Camden campuses, the police chiefs report to the Office of the Provost while following policies, procedures, and administrative practices established by the executive director for public safety.

Members of the public safety staff patrol each campus and respond to emergencies and requests for assistance on a full-time basis, 24 hours a day, 365 days a year. Rutgers public safety employees are only part of the universitywide crime prevention team. All members of the university community also are part of that team. As a team, it is everyone's duty to actively maintain a safe environment and be careful while complying with all local, state, and university regulations.

Information regarding public safety at Rutgers is available from the campus police departments. *Safety Matters* details public safety statistics, services, and programs on each of Rutgers' regional campuses. To have a printed copy of *Safety Matters* mailed to you free of charge, please contact the appropriate Rutgers University Police Department office at one of the following numbers, or view the online version at any of the following web sites:

Camden Campus:	*http://www.camden.rutgers.edu/ ~rupdcamd/index.htm* **856/225-6009**
Newark Campus:	*http://newarkpolice.rutgers.edu* **973/353-5581**
New Brunswick Campus:	*http://publicsafety.rutgers.edu* **732/932-8407**

Rutgers University Police Department

The Rutgers University Police Department (RUPD) is dedicated to providing progressive community policing services that focus on the prevention of crime through the development of university-based partnerships. The RUPD provides police, security, and safety services, and is staffed by commissioned police officers with full investigative and arrest authority, a professional security staff, students trained as community service officers, student safety officers, dispatchers, and technical and administrative employees.

The university police department is located at 5 Huntington Street on the College Avenue campus. The campuses are patrolled on foot, in vehicles, and on bicycles. To contact the RUPD to report emergencies (police, fire, and emergency medical), dial 911; from university centrex telephones, obtain an outside line and dial 911. For nonemergency telephone calls to the police, dial 732/932-7211; from university centrex telephones, dial 2-7211. You also can contact the police by using any of the more than 60 blue light emergency telephone boxes on the campuses or by using the housing telephones located near residence hall entrances.

Community policing offices are located in each of the campus student centers. These frontline police officers act as community organizers, team builders, and problem solvers. They provide a communications link between the community and the police department, serve on campus bias committees, and perform proactive patrol. Security officers patrol the campuses, serving as "eyes and ears" for the police while securing facilities and providing escort services. Student safety officers and community services officers provide a host of other safety and security services that include controlling access to selected residence halls during evening hours. For more information on these programs, call 732/932-5400.

Emergency Services

Fire safety is a major component of our total safety and security program. State certified fire inspectors provide fire safety awareness training sessions in the residence halls and conduct emergency evacuation drills to familiarize occupants with emergency procedures. Emergency Services personnel regularly inspect all university buildings and facilities, conduct alarm tests and fire drills, and enforce the New Jersey Uniform Fire Code. As a state-licensed ambulance service, Emergency Services provides emergency medical care to the university community. The staff of New Jersey certified emergency medical technicians respond to emergency medical calls and provide standby services at major university events.

Sexual Assault Services and Crime Victim Assistance

Sexual Assault Services and Crime Victim Assistance staff provide support and assistance to crime victims, survivors, and other members of the university community. Advocacy, crisis intervention, counseling, and referrals are available. Programs and services for students, faculty, and staff promote ways of reducing the risk of being a crime victim and the availability of resources and options should a crime occur. With a special emphasis on crimes of interpersonal violence, educational programs are available to the university community on issues concerning sexual assault, domestic/dating violence, stalking, and peer harassment. For more information or to schedule an appointment or program, call 732/932-1181, visit the department web site at *http://www.rutgers.edu/SexualAssault/,* or email the staff at *sascva@rci.rutgers.edu.* The office is located at 3 Bartlett Street on the College Avenue campus, New Brunswick.

ADMINISTRATIVE PROCEDURES FOR RESPONDING TO DISRUPTIONS

An academic community, where people assemble to inquire, to learn, to teach, and to reason together, must be protected for those purposes. While all members of the community are encouraged to register their dissent from any decision on any issue and to demonstrate that dissent by orderly means, and while the university commits itself to a continual examination of its policies and practices to ensure that causes of disruption are eliminated, the university cannot tolerate demonstrations that unduly interfere with the freedom of other members of the academic community.

With this in mind, the following administrative procedures have been formulated to guide the implementation of university policy:

1. The president of the university and the university vice president for academic affairs will have the authority throughout the university to declare a particular activity to be disruptive. In the two geographic areas of Camden and Newark, the respective provost will have the same authority. In New Brunswick, the senior vice president and treasurer will have the same authority.
2. Broadly defined, a disruption is any action that significantly or substantially interferes with the rights of members of the academic community to go about their normal business or that otherwise unreasonably interrupts the activities of the university.
3. A statement will be read by the appropriate officers as specified in (1) or by such officers as they may designate for the purpose of such reading and will constitute the official warning that the activity is in violation of university policy, that it must cease within a specified time limit, and where appropriate, that no commitments made by university officials will be honored if those commitments are made under duress.
4. If the activity continues beyond the specified time limit as determined by the official in authority, the authorized officers as specified in (1) will have the discretion to call upon the university police to contain the disruption. Ordinarily, the president of the university alone, or in his or her absence the university vice president for academic affairs, will have the authority to decide that civil authorities beyond the campus are to be called upon to contain those disruptions that the university police are unable to handle. In extraordinary circumstances, where neither the president nor the university vice president for academic affairs is available to make such a decision, the senior vice president and treasurer in New Brunswick and the provosts on the Camden and Newark campuses have the same authority.
5. The deans of students are the chief representatives of the deans of the colleges in all matters of student life. Members of the university community who are aware of potentially disruptive situations are to report this to the deans of students on their respective campuses. In a disruption, the deans of students and their staff members have a twofold responsibility: to protect against personal injury and to aid in providing for the order of the university. In the latter case, the deans of students, as well as other university personnel, may be called upon to coordinate or assist members of the academic community in ending the disruption, directing it to legitimate channels for solution, or identifying those who have violated the rights of others.

POLICY PROHIBITING HARASSMENT

The university prohibits harassment based on race, religion, color, national origin, ancestry, age, sex, sexual orientation, disability, marital status, or veteran status. Harassment is a form of discrimination that violates state and federal civil rights laws. It is defined for purposes of those laws and the university's policy as any behavior that

1. is unwelcome,
2. targets a person because he or she has one or more of the protected characteristics,
3. is engaged in by a person employed by or doing business with the university, and

4. is sufficiently severe or pervasive to alter negatively that person's or a group member's living, educational, or working environment.

Sexual harassment can take the form of unwelcome sexual advances; requests for sexual favors; or other unwelcome written, verbal, electronic, telephonic, or physical conduct of a sexual nature. *Hostile environment harassment* on the basis of sex, race, religion, color, national origin, ancestry, age, sexual orientation, disability, marital status, or veteran status is severe or persistent behavior that has the purpose or effect of unreasonably interfering with a person's work or academic performance or creating a hostile environment.

If you think you have been harassed on the basis of any of the protected categories listed above, have observed harassing behavior, or need more information, you are encouraged to contact Jayne M. Grandes, Director of University Harassment Compliance and Equity, Rutgers, The State University of New Jersey, 56 Bevier Road, Piscataway, NJ 08854, 732/445-3020, ext. 626, or by email at *uhce@hr.rutgers.edu.* You may obtain copies of the *Policy Prohibiting Harassment* and the *Harassment Complaint Process* on our web page at *http://uhr.rutgers.edu/uhce.*

POLICY AGAINST VERBAL ASSAULT, DEFAMATION, AND HARASSMENT

Statement of Principles

Intolerance and bigotry are antithetical to the values of the university and unacceptable within the Rutgers community. One of the ways the university seeks to effect this principle is through a policy of nondiscrimination, which prohibits discrimination on the basis of race, religion, color, sex, age, sexual orientation, national origin, ancestry, disability, marital status, or veteran status in university programs. In order to reinforce institutional goals of nondiscrimination, tolerance, and civility, the following policy against verbal assault, defamation, and harassment makes clear that such behavior toward others violates acceptable standards of conduct within the university. (This policy is not intended to supersede the university's policy against harassment.)

Verbal assault, defamation, or harassment interferes with the mission of the university. Each member of this community is expected to be sufficiently tolerant of others so that all students are free to pursue their goals in an open environment, able to participate in the free exchange of ideas, and able to share equally in the benefits of our educational opportunities. Beyond that, each member of the community is encouraged to do all that she or he can to ensure that the university is fair, humane, and responsible to all students.

A community establishes standards in order to be able to fulfill its mission. The policy against verbal assault, defamation, and harassment seeks to guarantee certain minimum standards. Free speech and the open discussion of ideas are an integral part of the university community and are fully encouraged, but acts that restrict the rights and opportunities of others through violence, intimidation, the destruction of property, or verbal assault, even if communicative in nature, are not protected speech and are to be condemned.

Prohibited Conduct

Any of the following acts, even if communicative in nature, are prohibited "separation offenses" (charges that could lead to suspension or expulsion from the university) under the provisions of the University Code of Student Conduct:

1. Use of force against the person or property of any member of the university community or against the person or property of anyone on university premises, or the threat of such physical abuse. (Verbal assault may be prosecuted as a "threat of . . . physical abuse.")
2. Theft of, or intentional damage to, university property, or property in the possession of, or owned by, a member of the university. (Acts of graffiti or other vandalism may be prosecuted as "intentional damage to . . . property.")
3. Harassment, which is statutorily defined by New Jersey law to mean, and here means, purposefully making or causing to be made a communication or communications anonymously or at extremely inconvenient hours, or in offensively coarse language, or in any other manner likely to cause annoyance or alarm, or subjecting or threatening to subject another to striking, kicking, shoving, or other offensive touching, or engaging in any other course of conduct or of repeatedly committed acts with purpose to alarm or seriously annoy any other person. Harassment is considered a separation offense under the University Code of Student Conduct.
4. Defamation, which is judicially defined to mean, and here means, the unprivileged oral or written publication of a false statement of fact that exposes the person about whom it is made to hatred, contempt, or ridicule, or subjects that person to loss of the goodwill and confidence of others, or so harms that person's reputation as to deter others from associating with her or him. Defamation is considered a separation offense under the University Code of Student Conduct.

While any of the four categories of acts listed above is a separation offense that, if proven, could lead to a sanction of expulsion or suspension from the university under the provisions of the University Code of Student Conduct, clearly minor instances of such prohibited behavior should be resolved at the college level and not be treated as separation offenses requiring a university-level hearing. The initial judgment of whether a particular act is of a separable or nonseparable nature is made by the appropriate college official.

Students who believe themselves to be victims of verbal assault, harassment, or defamation should report such incidents to the dean or the dean of students of their college or school. In addition, the following individuals have been identified to handle complaints:

Brian T. Rose, director of compliance, student policy, and judicial affairs, 3 Bartlett Street, College Avenue campus (732/932-7312);

Cheryl Clarke, director of diverse community affairs and lesbian/gay concerns, 3 Bartlett Street, College Avenue campus (732/932-1711);

Associate provost for student life, Armitage Hall, Room 248, Camden campus (856/225-6050);

Marcia W. Brown, associate provost for student affairs and community outreach, Center for Law and Justice, Newark campus (973/353-5234).

Some complaints can and should be resolved by informal methods, while others will require the implementation of formal procedures. All complaints are treated confidentially; complainants are encouraged to report incidents even if they do not wish to pursue the matter beyond the reporting stage.

NONDISCRIMINATION POLICY

It is the policy of Rutgers, The State University of New Jersey, to make the benefits and services of its educational programs available to students, and to provide equal employment opportunity to all employees and applicants for employment, regardless of race, religion, color, national origin, ancestry, age, sex, sexual orientation, disability, marital status, or veteran status. (Douglass College, as a traditionally and continuously single-sex institution, may, under federal law, continue to restrict college admission to women.) Questions concerning student rights violations should be addressed to Brian T. Rose, Director of Compliance, Student Policy, and Judicial Affairs (732 / 932-7312). Questions concerning harassment or employment discrimination should be directed to Jayne M. Grandes, Director of University Harassment Compliance and Equity (732 / 445-3020, ext. 626).

DRUG FREE SCHOOLS AND CAMPUSES ACT

The Drug Free Schools and Campuses Act requires institutions of higher education to adopt and implement a program to prevent the unlawful possession, use, or distribution of illicit drugs and alcohol by students and employees. In compliance with this federal regulation, Rutgers has various policies and programs in place. The University Code of Student Conduct, available at *http://www.rci.rutgers.edu/~judaff/code.htm,* or through the Assistant Director of Student Judicial Affairs (732 / 932-9414), provides information regarding prohibited conduct and sanctions related to drug and alcohol possession, use and distribution. The University also has adopted a Policy on the Use of Alcoholic Beverages that can be accessed online at *http://www.rci.rutgers.edu/~polcomp/alcohol.shtml.* In addition, Rutgers offers extensive educational resources and programming related to alcohol and other drugs through University Health Services. Students can access educational materials and program information online at *http://health.rutgers.edu/healthinfo/alcohol.htm.* More comprehensive information regarding the Drug Free Schools and Campuses Act is set forth in the Student Health Insurance Manual, located online at *http://health.rutgers.edu/insurance/ RUHSInsurancbook.pdf,* and is provided to all new students.

EQUITY IN ATHLETICS DISCLOSURE ACT REPORTS

In compliance with the Equity in Athletics Disclosure Act, Rutgers provides information on men's and women's athletic programs *(http://athletics.rutgers.edu/),* including the number of participants by gender for each varsity team, operating expenses, recruiting expenditures, athletically

related student aid, and revenues. The first report was issued in October 1996 with annual updates thereafter. The reports are available at the reference desks of the main branches of the university library system (Alexander Library, Library of Science and Medicine, Robeson Library, and Dana Library), and at the intercollegiate athletics offices.

GRADUATION RATES

The IPEDS Graduation Rate Survey is an annual report of graduation rates of the university's degree-seeking, full-time undergraduate students by gender and race / ethnicity, and by sport for those who received athletically related student aid. This report is available at *http://oirap.rutgers.edu/disclosure.html.*

TEACHER PREPARATION PROGRAM PASS RATES

In compliance with the Higher Education Act, Rutgers provides data on Teacher Preparation Program pass rates and related issues. Detailed information about Rutgers' report to the state can be found at *http://oirap.rutgers.edu/disclosure.html.*

STUDENT RECORDS AND PRIVACY RIGHTS

Rutgers, The State University of New Jersey, complies with the Family Educational Rights and Privacy Act (FERPA). FERPA affords students certain rights with respect to their "education records" as that term is defined in the law. These rights include the following:

1. The student has the right to inspect and review his or her education records within 45 days of the date Rutgers receives a proper request for access to such records.
2. The student has the right to request amendment of education records that the student believes are inaccurate or misleading.
3. Rutgers shall obtain the prior consent of the student before disclosing personally identifiable information contained in the student's education records, except to the extent FERPA authorizes disclosure without consent.
4. The student may direct complaints concerning the alleged failure of Rutgers to comply with the requirements of FERPA to the Office of Compliance, Student Policy, and Judicial Affairs, 3 Bartlett Street, College Avenue campus (732 / 932-7312) or to the U.S. Department of Education, c/o Family Policy Compliance Office, U.S. Department of Education, 400 Maryland Avenue SW, Washington, DC 20202-4605.

Students wishing to exercise their rights to inspect and review their education records should submit a written request to the appropriate official at the Rutgers office which is custodian of the records they wish to review. Students requesting amendment of education records should first review the policies and procedures of their college or school and / or consult with their dean of students, or equivalent official. FERPA permits disclosure of directory

information without a student's consent, unless the student has requested such information be kept confidential. Directory information includes the student's name, address, phone, school of attendance, and several other fields of information. For information on how to keep your directory information confidential, visit the Rutgers Online Directory by using the "Find: People" link of the Rutgers home page *(http://www.rutgers.edu),* or contact the Office of the Registrar on your campus. Rutgers uses a student's social security number as an identification number. While the number is not released as directory information and its confidentiality is protected in the same manner as are other educational records, Rutgers offers students the opportunity to acquire a substitute number. Students wishing to have a substitute number assigned must go to the registrar's office with two forms of identification and complete the appropriate forms. Rutgers publishes two official notices concerning FERPA at least twice per academic year. The official notices are archived on the Office of Compliance, Student Policy, and Judicial Affairs web site at *http://www.rci.rutgers.edu/~polcomp.* The notices provide full information on Rutgers' compliance with FERPA including the current definition of "directory information." Students with questions about FERPA or the privacy of their records should consult these notices and/or contact the Office of Compliance, Student Policy, and Judicial Affairs, 3 Bartlett Street, College Avenue campus (732/932-7312, *cspc@rci.rutgers.edu).*

STUDENT RESIDENCY FOR TUITION PURPOSES

A determination of residency status for the purpose of tuition assessment is made by the university based on information provided by the applicant in accordance with the procedure outlined in the policy. Acopy of the policy may be secured from the registrar's office or the admissions office.

Procedure

The Initial Determination

At the time an individual initially applies for admission into any graduate or undergraduate college or division of the university, the respective admissions office determines an admitted applicant's resident status for tuition assessment.

The determination made at this time shall prevail for each term unless a change is authorized as provided hereinafter.

After the Initial Determination

The status of residency for tuition purposes of students continuing in a college or division of the university is determined by the registrar of the respective college or division. The determination made by the registrar either conforms to the initial determination of the admissions office or reflects a change as provided hereinafter.

Request for a Change of Status

Requests for a change in residency status are accepted no later than the last day of the term for which changed status is sought. All supporting affidavits, deemed appropriate by the adjudicating official pursuant to New Jersey Administrative Code, Volume 9, Section 5 et seq., must be filed by the petitioner in accordance with the time limit

specified in the preceding sentence. In no case may supporting affidavits be filed later than four weeks from the conclusion of the term for which the residency assessment is requested. Failure to comply with this provision, unless judged otherwise by the adjudicating official, voids the petition for the term in question. If, based on the information submitted in the request, the student qualifies for resident tuition assessment, such change relates only to the current and subsequent terms. No adjustments in tuition assessments are made and no refund vouchers are processed for any prior term.

Appeals

Appeals from the initial determination and any determination made after a request by a student for a change in residency status are accepted no later than three months after the date of notification of any such determination. Unresolved appeals are forwarded to either the associate vice president for enrollment management or the university registrar. These officers respond to the student within 30 working days of the receipt of the appeal in the appropriate office. Appeals from this determination should be submitted to the vice president for university budgeting by the student within two weeks after the director of admissions or the university registrar has issued a determination. The decision of the vice president for university budgeting is final.

Students' Responsibilities

Students are responsible for providing relevant information upon which a residency determination can be made. The burden of proving his or her residency status lies solely upon the student. Moreover, it is considered the obligation of the student to seek advice when in doubt regarding eligibility for in-state tuition assessment. If the student neglects to question his or her eligibility status beyond the period specified above, that student forfeits his or her right to a residency assessment to which he or she might have been deemed to be eligible had he or she filed an appeal at the appropriate time.

Penalties

If a student has obtained or seeks to obtain resident classification by deliberate concealment of facts or misrepresentation of facts or if he or she fails to come forward with notification upon becoming a nonresident, he or she is subject to disciplinary action.

RESEARCH POLICY AND RESEARCH CENTERS

Research at the university, apart from that conducted by students in connection with their academic course work, is in general intended to lead to publication in some form so that its results are available to interested persons everywhere. All university-conducted research must be available for public scrutiny and use. The university does not accept grants from or enter into contracts with governmental agencies or any other sponsors for research projects of which the results may not be made publicly accessible.

Most research projects at the university are carried on by faculty members and students within the facilities offered by their own departments. For on-campus research that

cannot be conducted in department facilities, laboratories, or the library, the university has provided a number of cooperative research centers and bureaus. A list of the university's research centers may be found in the Divisions of the University chapter.

Many members of these organizations are active in graduate instruction. Information about their programs and activities may be found in *Research at Rutgers,* a handbook and bibliography published by the Research Council, the university agency that sponsors and coordinates faculty research.

PATENT POLICY

All students are governed by the university's patent policy, which is described in a statement available in the Office of Research and Sponsored Programs and the offices of all deans and department chairpersons.

Degree Requirements

This chapter outlines the minimum requirements of the Graduate School–New Brunswick for each of the advanced degrees under its jurisdiction. The faculty in charge of each program may impose additional requirements. The most significant of these additional requirements are announced in the program descriptions, arranged alphabetically by subject, in the Programs, Faculty, and Courses chapter.

DOCTOR OF PHILOSOPHY

The degree of doctor of philosophy (Ph.D.), introduced to this country by Yale in 1861, is the highest degree offered in American education. It is conferred in recognition of two accomplishments: (1) marked ability and scholarship in a broad field of learning (such as chemistry or classics), and (2) distinguished critical or creative achievement within a special area of the general field. The special field forms the subject of the doctoral dissertation. Astudent must devote a minimum of three years of full-time study beyond the bachelor's degree for the Ph.D., of which at least one year must be devoted to dissertation-related research. Full-time study for one year is represented by 24 credits of course work or research. The minimum requirement for the Ph.D. degree is, therefore, 72 credits, of which at least 24 credits must be devoted to research. If any of the work is conducted on a part-time basis, the minimum time required will, of course, be longer.

Doctoral programs normally are arranged in two phases. The preliminary phase, which generally involves formal courses of study, is completed when the student passes the qualifying examination. In the second phase, the student usually pursues research courses and writes his or her dissertation. This phase concludes when the dissertation is accepted and the defense of it is approved. Between admission to the Graduate School–New Brunswick and the conferral of the Ph.D. degree, the student must (1) satisfy the course and other preliminary requirements of the particular graduate program in which the student is enrolled, (2) pass the comprehensive qualifying examination, (3) present the results of the special research in an acceptable dissertation, and (4) pass a final examination related to the subject of the dissertation. The student becomes a formal candidate for the doctorate only after completing the qualifying examination.

Residence Requirements

Residence requirements for advanced degrees are determined by the faculty of each program. Students should consult their graduate directors for information concerning minimum expectations of concentration for their programs of study.

Transfer of Credit

Graduate courses completed at other institutions may be accepted for credit toward a doctorate at the university if they meet three conditions. First, they normally must form part of the student's field of concentration. Second, the

student must have been registered in these courses within the preceding six years. In some instances, however, the dean can waive this requirement if the student can show he or she has kept abreast of the subject matter in question. Finally, the student must have earned a grade of *B* or better in these courses. Graduate credit may not be transferred until 12 credits of graduate courses with grades of *B* or better have been completed in the Graduate School–New Brunswick as a matriculated student. The maximum number of credits a student may transfer is 50 percent of the total number of course credits in his or her program, exclusive of research. In no case, however, may this total exceed 24 credits. The faculty of a graduate program may recommend the transfer of credits earned at a professional or graduate school elsewhere toward a Ph.D. in the Graduate School–New Brunswick. No credit may be transferred for thesis-related research work, course work done as independent study, or course work that was not graded with an *A* or *B*. Other letter or numerical grades are eligible for transfer if the student earned the equivalent grade of *B* or better and if he or she submits a letter from the instructor of the course testifying to that equivalence. See the Academic Policies and Procedures chapter for additional information.

Language Requirements

Language requirements for advanced degrees in the Graduate School–New Brunswick are determined separately by each program. Information about requirements may be found in the Programs, Faculty, and Courses chapter under each program.

When programs require that proficiency in one or more foreign languages be demonstrated by a written examination, the programs may supervise their own examinations or ask their students to pass the examinations offered on several dates throughout the year by the FAS–NB Language Laboratory on behalf of the Graduate School–New Brunswick. These examinations are given in Greek, Latin, French, German, Russian, Chinese, Spanish, Italian, and Portuguese. In each, the student is asked to translate passages with the aid of a dictionary. Students must apply in advance to take an examination, which is graded on a pass or fail basis.

Registration information and instructions are available at the FAS–NB Language Laboratory, Seminary Place, College Avenue campus. A fee of $15 is charged. The results of the examinations are reported to graduate offices as soon as they become available, usually in about two weeks. The student's program director certifies the results of the examination (or examinations) on the student's Ph.D. candidacy form.

Program of Study

A student who wishes to qualify for the doctorate should formulate a program of study in consultation with his or her graduate adviser or committee. The course and research requirements for the doctoral degree in each subject are determined by the faculties concerned, although all programs are subject to review by the dean of the Graduate School–New Brunswick. The minimum total requirement of nonresearch courses varies by program, although it rarely exceeds 48 credits. The student must offer a minimum of 24 credits in research toward the degree. The minimum combined total credit requirement is 72 credits. No more than 12 credits of advanced undergraduate courses

(300 or 400 series with added *G* prefixes) may be offered toward the degree. No more than 50 percent of a student's formal course work may be taken in professional school courses. In most programs, a student is able to complete course work in two years of full-time study. Courses taken to satisfy the requirements for a master's degree may, with program approval, be counted toward the doctorate. The time of transition from course work to guided or independent research is determined by the faculty of the student's program. The entire doctoral program should be completed no later than seven years after the student first registers in the Graduate School–New Brunswick.

Academic Standing

Prospective candidates for the doctorate should understand that they ordinarily will not be permitted to proceed to the qualifying examination unless their record in course work shows evidence of distinction. The standard of work required is left largely in the hands of the student's program committee. It is expected, however, that no more than 9 credits offered in partial fulfillment of the requirement for the doctorate, and for which letter grades have been given, shall bear grades of *C* or *C+*. Most programs expect graduate students to achieve grades of *B* or better in all of their courses. The regulations in some programs assume that a student probably should not continue to the doctorate unless he or she demonstrates a capacity to perform with distinction (i.e., grades of *A*) in at least half of his or her formal studies.

Admission to Candidacy:
The Qualifying Examination

The qualifying examination is given to determine whether a student has acquired sufficient mastery of the field of concentration to warrant admission to candidacy for the Ph.D. degree. The exam should be taken as soon as a student has completed the major portion of the course requirements. It should be taken not later than four years after the student first registered in the Graduate School–New Brunswick and not later than two terms before taking the final dissertation examination.

The comprehensive examination, conducted by a committee of at least four members (the chairperson must be a member) or associate members of the program's graduate faculty, may be written or oral or both. Once a student has fulfilled the language requirements, if applicable, and other relevant program requirements, and has passed the qualifying examination, he or she is admitted to candidacy for the doctoral degree. The student's program will certify the results of his or her language examination on the application for admission to candidacy for the doctoral degree. The student must obtain this application from the office of the graduate school and submit it to the chairperson of the committee at the time of the examination. It should be properly signed by the four members of the candidate's committee and the graduate director and then returned to the Office of the Graduate School. Once a student has passed the examination, he or she must remain registered—for courses or research—or lose his or her status as a candidate. An exception to this rule may be granted to recipients of the master of philosophy degree (see the section concerning that degree later in this chapter).

Dissertation and Dissertation Committee

Each candidate for the doctorate pursues, under faculty direction, an original investigation of a problem or problems in a field of concentration and presents the results of the investigation in a dissertation. The dissertation must be approved by a minimum of three members of a faculty committee of four members. The member of the program faculty who supervises the student's investigation becomes chairperson of the committee. The panel also includes two members or associate members of the program faculty and an "outside" member, who is appointed by the program director in consultation with the student's adviser. Whenever possible, "outside" shall be "outside the university," but in all cases this person must come from outside the program. The outside member is expected to be a recognized authority on the subject of the dissertation. For appointments of committee members who are not members of the graduate faculty, the program director will forward to the Office of the Graduate School a letter appointing the individual to the committee. This letter should explain the basis for the appointment and must include the address of the appointee.

For committees having more than four members, only one nonapproval is permitted. Substitutions in committee membership, once it has been determined, are the responsibility of the program director. Replacements will occur only if a member is unable to serve or if a student's dissertation topic changes, requiring a new dissertation director and/or modification in the committee. In cases other than these, approval for changes in committee membership rests with the dean of the Graduate School–New Brunswick.

The committee will meet to discuss the candidate's dissertation proposal once the candidate has developed some preliminary guidelines with the advice of the dissertation supervisor. Whenever possible, the outside member of the committee will be at this initial meeting. Subsequently, the committee must be kept informed of the student's progress and must agree to follow the candidate's work and assist in its development. The committee also shall agree to give ample and early warning of any reservations concerning the student's progress and must specify in writing the changes required for dissertation acceptance. The final copy of the dissertation should be prepared in strict accordance with the instructions given in the pamphlet *Style Guide for Thesis and Dissertation Preparation,* available at the Office of the Graduate School. After the dissertation has been accepted by the committee, the required copies are to be filed with the Office of the Graduate School no later than the announced deadlines for completion of degree requirements. One copy will be bound and made available in a university library. With the dissertation, the candidate is required to submit an abstract, *not exceeding 350 words,* that embodies the principal findings of his or her research. As with the dissertation, the abstract must be approved by the professor in charge of the work for the dissertation and accepted by the other members of the student's committee.

Final Examination

A final public examination is held under the auspices of the committee in charge of the candidate's course of study. A candidate must defend the dissertation and otherwise satisfy the committee and other faculty members in attendance that he or she is qualified to receive the degree of doctor of philosophy.

At the time of the final examination, it is the responsibility of the candidate to obtain from the Office of the Graduate School the candidacy application (on which the result of the qualifying examination was recorded) for completion by the committee at the final examination. The same committee members also must sign the title page of the dissertation, signifying their acceptance of it. Once the program director certifies that all program requirements have been completed for the degree of doctor of philosophy, the candidate must return the candidacy application to the Office of the Graduate School. The two required copies of the thesis or dissertation submitted must be of excellent quality, correct in margin and format, and on 100 percent rag or cotton content bond paper. All of the above materials must be submitted to the Office of the Graduate School no later than the announced deadlines for completion of degree requirements. The names of those failing to meet these deadlines will be removed automatically from the commencement list for that degree date.

Application for the Conferral of the Degree

The candidate must file a diploma application according to announced deadlines in order to receive a diploma at commencement. For further information regarding the application procedure, see Graduation at the end of this chapter. A certificate of completion is issued, upon request, in advance of the awarding of the diploma in May.

Publication of Dissertation and Academic Data

After the granting of the doctorate, the Graduate School–New Brunswick will have the dissertation microfilmed. The dissertation, therefore, must be prepared with the same care as if it were to appear in printed form. As the abstract that must accompany the dissertation will be published in *Dissertation Abstracts,* it also must be ready for publication when it is submitted to the dean.

Bell and Howell of Ann Arbor, Michigan, will microfilm the dissertation and publish the abstract. Information concerning the preparation of the dissertation and abstract and the agreement with Bell and Howell that the candidate must sign are available in the Office of the Graduate School. The fee for microfilming the dissertation and publishing the abstract is $55. Registration of copyright also is available for a fee of $45.

Calendar for the Doctoral Degree Program

The following deadlines should be observed by a candidate for the doctorate. The candidate must satisfy admission conditions early in the academic program and complete any language requirements before taking the qualifying examination. The candidate also must take the qualifying examination at least two terms before the final examination. In addition, he or she must file the required copies of the dissertation, complete the final examination, and return the candidacy form (which indicates the results of that examination) by the established deadlines for completing degree requirements. Finally, candidates must file their diploma applications by the appropriate deadline. At no point during this sequence may students allow their registration in the Graduate School–New Brunswick to lapse (with the exception of a recipient of the master of philosophy degree). The entire program must be completed within the period specified under Time Limits for Degrees later in this chapter.

MASTER OF PHILOSOPHY

The master of philosophy (M.Phil.) degree is offered by the faculties of certain Ph.D. programs to students who achieve records of distinction during the predissertation phase of those programs. Doctoral programs in which the master of philosophy degree may be conferred are indicated in the Programs, Faculty, and Courses chapter. Because the master of philosophy is not designed as a terminal degree, its requirements are integrated with the requirements for the doctor of philosophy degree. The Graduate School–New Brunswick does not admit potential candidates for the master of philosophy degree to graduate study unless they are clearly qualified to pursue the doctorate, and prospective students interested in the degree are advised to apply for admission to doctoral programs.

This degree, introduced by the University of Toronto in 1962 and established by Yale University in 1966, requires a minimum of two years of advanced study beyond the baccalaureate degree. Placed between the master of arts or the master of science degree and the doctor of philosophy, the master of philosophy marks a student's successful completion of all requirements for the doctorate except the final phase of research and the dissertation. The regulations governing the master of philosophy degree at the university are designed to encourage students in their progress toward the doctorate. The degree is intended to provide recognition that a prospective doctoral candidate has successfully and expeditiously completed a major phase of graduate study and has achieved a comprehensive mastery of the general field of concentration. Recipients of the degree automatically proceed toward the Ph.D. degree.

Programs leading to the master of philosophy degree are substantially similar to the predissertation phase of doctoral programs. They differ primarily in their stipulations on minimum grade requirements, completion of all work within the specified time limit, and the requirement that either a thesis or essay must be completed. Eligible students who intend to proceed toward the doctorate and who wish to acquire a master's degree in the course of their doctoral studies are advised to seek the master of philosophy degree instead of (or in addition to) the degree of master of arts or master of science.

Transfer of Credit

Credit for graduate-level courses taken elsewhere may be accepted toward the master of philosophy degree under the conditions outlined under transfer of credit in the description of Ph.D. requirements. It is a special requirement for the master of philosophy degree, however, that in at least one-quarter of the courses for which transfer of credit is desired the student must have earned a grade of A or its equivalent. Further restrictions concerning the transfer of credit may be found in the Academic Policies and Procedures chapter.

Program of Study

The requirements for the master of philosophy degree include a minimum of 48 credits of work, of which at least 42 credits must consist of course work. The remainder, with the approval of the student's program, may consist of research associated with an M.A. or M.S. thesis. At least 33 credits of the course requirements must be fulfilled in graduate-level courses numbered in the 500s and 600s, and of these at least 24 credits must be earned in courses taken at the university.

Academic Standing

To qualify for the master of philosophy degree, the student must earn a grade of A in at least 12 credits of the graduate-level courses that are taken at the university. No more than 3 credits bearing the grade of C or $C+$ may be counted toward the degree, and students earning 9 credits or more bearing grades of C or $C+$ or lower are ineligible for the degree.

Writing Requirement

Students who earn an M.A. or M.S. degree at the university are required to submit a master's thesis or a critical or expository essay in partial fulfillment of the requirements for the degree. Students seeking a master of philosophy degree are viewed as meeting the writing requirement for that degree if they already have submitted a formal thesis for the lower-level master's degree. Students who have not submitted a formal master's thesis can meet the master of philosophy writing requirement with a critical or expository essay that was accepted by their program faculty for the lower master's degree or with a similar essay written during their graduate work at the university. The thesis or essay must have been written under the direction of a member of the graduate faculty and approved by two other members of the graduate faculty.

Time Limits

All requirements for the master of philosophy degree must be completed within four consecutive academic years of first registration at the university. Students for whom transfer of credit is granted for graduate work done elsewhere must complete their program within commensurately shorter limits. Extensions of time normally will not be granted in connection with this degree.

Other Requirements

All other requirements for the Ph.D. degree established by the Graduate School–New Brunswick and by the faculty in charge of the student's program, other than the doctoral dissertation and the dissertation examination, must be fulfilled by applicants for the master of philosophy degree. These include completing all doctoral program requirements and passing the qualifying examination.

Continuing for the Ph.D. Degree

Students who have been awarded a master of philosophy degree may proceed directly toward the Ph.D. if they are admitted into the program and continue their registration. On the other hand, these students may elect to allow their registration to lapse for as long as four years without paying a restoral fee. To activate a lapsed registration, the student must submit an application for readmission to the Graduate School–New Brunswick at any time within the four-year window. With the program director's endorsement, readmission is automatic within the four years. (See Readmission in the Academic Policies and Procedures chapter.) After more than four years, holders of the master of philosophy degree may apply for readmission, but their graduate director may require them to take a refresher course or meet other requirements for readmission.

MASTER OF ARTS/MASTER OF SCIENCE

Candidates for the master of arts (M.A.) or master of science (M.S.) degree must satisfy the requirements of the Graduate School–New Brunswick and those of their particular program. The requirements of the Graduate School–New Brunswick are given below, and additional requirements established by various program faculties may be found in the Programs, Faculty, and Courses chapter. Certain programs have a foreign language requirement.

The minimum requirement to earn the master's degree is 30 credits of successful graduate study in course work. The candidate also must pass a comprehensive examination in his or her field of concentration. In some programs, but not all, a research program culminating in a thesis may be required. This thesis project usually replaces 6 credits of regular graduate courses normally taken in a nonthesis program. The 30 credits, representing at least one academic year of advanced study, must be completed no later than three years after first registration unless an extension of time is granted by the Graduate School–New Brunswick. For further information, see Time Limits for Degrees later in this chapter.

The student's registration in the Graduate School–New Brunswick must be continuous from the time of admission to graduate study until the time the degree is conferred. In fulfilling course requirements, courses may be selected from a single program or from several related programs. All programs of study are subject to review by the dean of the Graduate School–New Brunswick.

Transfer of Credit

On the recommendation of the program and with the approval of the Graduate School–New Brunswick, a student may transfer as many as 12 graduate credits as partial fulfillment of the 30-credit degree requirements. For further information, see Transfer of Credits in the Academic Policies and Procedures chapter.

Program of Study

When programs include pursuit of a research problem developed in a master's thesis, 6 credits of the total of 30 credits in the program are devoted to research for the thesis and writing the actual document. In exceptional cases, when it is desirable to give greater emphasis to the research project, the dean of the Graduate School–New Brunswick may, upon recommendation of the candidate's program, approve a maximum of 12 credits for research on an unusual problem and its treatment in the thesis.

In some master's programs, students pursue their degrees entirely through course work without writing a research thesis. In these cases, candidates must demonstrate to the faculty that they have the ability to write a creditable expository or critical essay as part of a seminar or special course designed for that purpose.

In programs consisting entirely of course work, at least 18 of the 30 credits of study must be undertaken in graduate-level courses (those numbered in the 500s and 600s). In programs in which a master's thesis accounts for a normal portion of the credit recorded, at least 12 credits of study must be undertaken in graduate-level courses. With the approval of the candidate's program faculty, the balance of his or her study in courses may be undertaken either in advanced undergraduate courses (numbered in the 300s and 400s) or in additional courses designed primarily for

graduate students. In no case may the candidate for the master of arts or master of science degree offer more than 12 units of credit of advanced undergraduate course work.

Academic Standing

Candidates for the master's degree normally are expected to earn grades of *B* or better in their course work. No more than 9 credits (fewer in some programs) bearing grades of *C* or *C+* may be used in meeting the requirements for a master's degree.

Committees and Advisers

When a student's program includes a thesis, the supervision of the course of study, the research for the thesis, and the conduct of the final examination are entrusted to a committee whose members are selected in consultation with the director of the graduate program. Each committee consists of at least three members or associate members of the graduate faculty in the student's graduate program. One nonprogram member is permitted, but this selection must be approved by the director of the graduate program. If the student's program does not include a thesis, the committee is appointed shortly before the final examination. A nonthesis committee consists of at least three members or associate members of the graduate faculty in the student's graduate program. No substitutes are permitted. In either case, the student is encouraged to seek advice during the course of study from the graduate director, committee chairperson, and professor supervising his or her courses. No graduate student should regard a program of study as the mere accumulation of numerical credits and meeting of formal requirements. Progress toward mastery of a discipline depends largely upon the guidance of the professors in charge of the effort and upon the student's initiative.

Submission of the Thesis

For a student whose program includes a thesis, that thesis must be approved by the professor in charge and accepted by the other members of the student's committee. The final draft of the thesis should be prepared in strict accordance with the instructions given in the pamphlet *Style Guide for Thesis and Dissertation Preparation,* available at the Office of the Graduate School. After the thesis has been accepted by the committee, the required copies are to be filed with the Graduate School–New Brunswick by the announced deadlines for completion of degree requirements.

Master's Examination

An application for candidacy for the master's degree must be submitted to the dean of the Graduate School–New Brunswick at least two months before the final examination.

If a student expects to take the final examination at the end of the Summer Session or at the beginning of the fall term, the application must be filed before the Summer Session starts. Forms for this purpose are available at the Office of the Graduate School, and responsibility for making the application lies with the student.

The final comprehensive examination may be written or oral, or it may be a combination. Just before a student is to take the comprehensive examination, he or she must obtain, from the Office of the Graduate School, a copy of the previously filed application and submit that copy to the chairperson of the committee. The chairperson and committee members record the results of the examination on this

form. It is the responsibility of the candidate to obtain the approval of the graduate program director and to return the form to the Office of the Graduate School. The form should be returned soon after the examination and no later than the announced deadlines for completion of degree requirements. The names of those failing to meet the deadline will be removed automatically from the commencement lists.

Qualifying Examination for the Doctorate Used for the Master's Degree

A student who has satisfied all other requirements for a master's degree except the final examination may, with the permission of the program faculty, elect to take the qualifying examination for the doctorate in place of the final master's examination. After passing the qualifying examination, these students may be recommended for the appropriate master's degree. This use of the qualifying examination does not invalidate the status of a student as a candidate for the doctor's degree. Astudent who desires to use the qualifying examination as the final examination for the master's degree must file an application for the master's degree in accordance with the preceding directions.

Application for the Conferral of the Degree

The candidate must file a diploma application before posted deadlines in order to receive the degree at commencement. For further information regarding the application procedure, see Graduation at the end of this chapter.

Calendar for the Master's Degree Program

The candidate must file an application for a master's degree early in the same term that included the scheduled final examination. It is assumed at this point that grades from previous courses are available. If the program includes a thesis, two copies of the thesis and the completed candidacy form must be filed according to the announced deadlines for completion of degree requirements. Finally, the diploma application must be filed by the appropriate deadline. At no point during this sequence should the student allow academic year registration in the Graduate School–New Brunswick to lapse. Master's students preparing for comprehensive examinations may register for Matriculation Continued for a maximum of two terms. Master's students writing theses must maintain continuous registration for a minimum of 1 research credit per term; a maximum of three such terms is allowed. The entire program must be completed within the period specified under Time Limits for Degrees later in this chapter.

MASTER OF ARTS FOR TEACHERS/MASTER OF SCIENCE FOR TEACHERS

Programs leading to the degree of master of arts for teachers (M.A.T.) or master of science for teachers (M.S.T.) are offered in the Graduate School–New Brunswick to teachers at secondary schools who wish to further their academic education. Prospective students should be advised that these programs do not lead to certification in teaching nor are they degrees in education, which are offered by the Graduate School of Education. The programs of study for the M.A.T. and M.S.T. degrees are designed on an individual basis. All M.A.T. and M.S.T. programs at the university

are comprised primarily of work in regular courses of study, and none provides for the submission of a thesis. The other requirements governing the degree may be found in the preceding account of requirements for the degrees of master of arts and master of science.

TIME LIMITS FOR DEGREES

Degree programs should be completed within the following periods of time after first registration in the Graduate School–New Brunswick:

	Normal Minimum (full-time study)	Normal Maximum
Master of Arts	1 year	3 years
Master of Science	1 year	3 years
Master of Arts for Teachers	1 year	3 years
Master of Science for Teachers	1 year	3 years
Master of Philosophy	2 years	4 years
Doctor of Philosophy	3 years (2 years beyond master's)	7 years (4 years beyond master's)

All students are urged to consider the educational and economic benefits of completing their programs quickly. Soon after being admitted to graduate study, each student should consult with a faculty adviser and work out a reasonable timetable for meeting the requirements. Extensions beyond the normal limits shown above (for all degrees except the master of philosophy) may be granted to students in good standing. Astudent requiring an extension should petition the dean of the Graduate School–New Brunswick on a form available from the Office of the Graduate School. If the petition is supported by reasons of weight, and if the faculty members in charge of the student's program certify that satisfactory progress is being made, the extension normally is granted. Part-time students should consult their program concerning their expected times of completion.

THESIS AND DISSERTATION PREPARATION

A pamphlet entitled *Style Guide for Thesis and Dissertation Preparation* is available at the Office of the Graduate School. All theses, dissertations, or essays submitted to the Graduate School–New Brunswick in partial fulfillment of the requirements for master's and doctor's degrees must conform to the instructions in this pamphlet. A thesis may be rejected by the graduate school office if it does not adhere to the stylistic and technical requirements specified in *Style Guide for Thesis and Dissertation Preparation.*

The Office of Academic Services provides a series of dissertation and thesis workshops to help students prepare their manuscripts for submission in accordance with the requirements of the Graduate School–New Brunswick. In addition to examining the various guidelines for dissertation and thesis preparation, the workshops give students the opportunity to ask questions about the format of their project. For schedule information, call 732/932-7034.

GRADUATION

When entering their final term, candidates who anticipate faculty recommendation for conferral of the degree are required to follow the procedures listed below:

1. Ensure that all academic requirements are being completed. If a student is unable to do so by the deadline date, both forms listed below must be refiled for a later-dated diploma.
2. Ensure that related fees and any outstanding debts to the university are paid.
3. Submit the completed candidacy application form by the announced deadline, normally in early January, May, or October.
4. Submit a diploma application form by the announced deadline, normally January 2, April 1, or October 1.

If this form is filed after the deadline, the degree cannot be conferred as scheduled, and graduation will be delayed. Students must refile this form if the deadline has passed. All forms are available from the Office of the Dean of the Graduate School. Students are urged to submit the appropriate forms in advance of the deadlines, if possible. It is the responsibility of the student to complete all requirements for graduation by the scheduled dates. All students should consult with the graduate director of their programs and with the Office of the Dean of the Graduate School about completing the requirements for graduation.

Conferral of degrees and diplomas occurs once a year at the annual spring commencement. However, students who file the applications and complete all other requirements for the degree by the announced October or January dates will get a diploma *dated* for the respective month, although they will not receive it until the following spring. Students may request a temporary certificate of completion by submitting a written request to the university registrar (Administrative Services Building, Busch campus). This request form may be obtained at the dean's office. At the time of commencement, degrees may be conferred *in absentia* only if the prospective candidate has notified the university registrar that he or she cannot attend the commencement exercises.

The diploma will be withheld from any student who has a financial obligation to the university.

Programs, Faculty, and Courses

In this chapter, detailed descriptions of the programs offered by the Graduate School–New Brunswick appear in alphabetical order by subject name. Under each program, information is provided about the degree or degrees offered, the name and campus address of the program director, a list of the members of the graduate faculty in charge of the program and their research interests, a description of the program's special purposes and requirements, and a list of courses. *Note:* For a comprehensive list of the degree programs offered by the Graduate School–New Brunswick, see the Degree Programs Available chapter.

COURSE INFORMATION

Courses numbered in the 500s and 600s are offerings of the graduate faculty for graduate students in advanced-degree programs. Undergraduate or nonmatriculated graduate students and students from the university's graduate professional schools are admitted to these courses according to rules printed elsewhere. Information about special prerequisites for some courses may be obtained from graduate program offices and from instructors at initial class meetings. Courses numbered in the 700s are intended for students preparing individual research theses or dissertations for advanced degrees.

Advanced undergraduate courses (numbered in the 300s and 400s) do not appear in this catalog, but among them are many that may serve as useful prerequisites to particular graduate courses. Under certain conditions, these courses may be accepted for credit toward graduate degrees. Within the limits described in the Degree Requirements and the Academic Policies and Procedures chapters, a student in the Graduate School–New Brunswick may register for an undergraduate course with the approval of his or her graduate adviser. Information about undergraduate course offerings must be sought in the appropriate undergraduate catalogs and separate schedules of classes. Graduate-level courses at the Rutgers professional schools and at Princeton University also must be sought out in the catalogs of those schools.

Explanation of Three-Part Course Numbers

The number preceding each course title is divided into three parts. The first two digits are the administrative code (standing for a faculty or a school), the next three digits are the subject code, and the final three digits are the course code.

Administrative Codes

The administrative code for the Graduate School–New Brunswick is 16. The following administrative codes may be relevant for graduate students in New Brunswick:

01 Faculty of Arts and Sciences–New Brunswick
08 Mason Gross School of the Arts (graduate courses)
15 Graduate School of Education (graduate courses)
16 Graduate School–New Brunswick
17 School of Communication, Information and Library Studies (graduate courses)
18 Graduate School of Applied and Professional Psychology
19 School of Social Work (graduate courses)
26 Graduate School–Newark
34 Edward J. Bloustein School of Planning and Public Policy
37 School of Management and Labor Relations
53 School of Business–Camden
56 Graduate School–Camden

Subject Codes

A subject code comprises the third through fifth digits in all course numbers and indicates the subject matter of the course. The following subject codes are used in this catalog:

016 African Studies
047 Alcohol Studies
067 Animal Sciences
070 Anthropology
082 Art History
098 Asian Studies
115 Biochemistry
118 BIOMAPS
125 Biomedical Engineering
126 Biotechnology
127 Bioresource Engineering
148 Cell and Developmental Biology
150 Ceramic and Materials Science and Engineering
155 Chemical and Biochemical Engineering
160 Chemistry
180 Civil and Environmental Engineering
185 Cognitive Science
190 Classics
194 Communication, Information, and Library Studies
195 Comparative Literature
198 Computer Science
215 Ecology and Evolution
220 Economics
300 Education
332 Electrical and Computer Engineering
350 English
352 English (Composition Studies)
356 English as a Second Language
370 Entomology
375 Environmental Sciences
378 Environmental Change, Human Dimensions of
395 Food and Business Economics
400 Food Science
420 French
450 Geography
455 Geospacial Information Science
460 Geological Sciences
470 German
510 History
540 Industrial and Systems Engineering
545 Industrial Relations and Human Resources
554 Interdisciplinary Studies
560 Italian
615 Linguistics
640 Mathematics
642 Mathematics, Applied
650 Mechanical and Aerospace Engineering
654 Mechanics
663 Medicinal Chemistry
667 Medieval Studies
681 Microbiology and Molecular Genetics
695 Molecular and Cell Biology
696 Molecular Biophysics
700 Music
709 Nutritional Sciences
710 Neuroscience
711 Operations Research
712 Oceanography
718 Pharmacology, Cellular and Molecular
720 Pharmacy (Pharmaceutical Science)
730 Philosophy
750 Physics and Astronomy
761 Physiology and Integrative Biology
765 Plant Biology
790 Political Science
830 Psychology
832 Public Health
841 Quaternary Studies

859 Russian, Central and East European Studies
910 Social Work
920 Sociology
940 Spanish
960 Statistics
963 Toxicology
970 Urban Planning and Policy Development
988 Women's and Gender Studies

Course Codes

The course code comprises the sixth, seventh, and eighth digits in all course numbers.

When two course codes are separated by a comma, each term course may be taken independently of the other. If two course codes are separated by a hyphen, students must complete satisfactorily the first course before taking the second one. Students may take the first course for credit without taking the second course unless a statement is added to indicate that both term credits must be taken in order to receive credit.

Other Course Notations

Courses noted (F) and (S) indicate fall and spring anticipated schedule. Not all courses are offered every term or year.

Credits awarded for the successful completion of each course are indicated in parentheses following the course title. The notation *BA* indicates that the number of credits is determined by arrangement with the program offering the course.

Unless otherwise indicated, a course normally meets for a number of lecture hours equal to the number of credits to be earned. Special hours or modes of class, other than lecture, are usually indicated in italics below the course title.

Abbreviations

The following abbreviations are used in the faculty listings:

BCAE   Biotechnology Center for Agriculture and the Environment
CABM   Center for Advanced Biotechnology and Medicine
CAFT   Center for Advanced Food Technology
CAS   Center of Alcohol Studies
CC   Cook College
CCACC   Center for Critical Analysis of Contemporary Culture
CCAS   Camden College of Arts and Sciences
CCES   Center for Coastal and Environmental Studies
CGS   Center for Government Services
CINJ   Cancer Institute of New Jersey
CMBN   Center for Molecular and Behavioral Neuroscience
CN   College of Nursing
CNCR   Center for Negotiation and Conflict Resolution
CTAG   Center for Theoretical and Applied Genetics
CUPR   Center for Urban Policy Research
EIP   Eagleton Institute of Politics
EJBSPPP   Edward J. Bloustein School of Planning and Public Policy
EMSP   Ernest Mario School of Pharmacy
FAS–C   Faculty of Arts and Sciences–Camden
FAS–N   Faculty of Arts and Sciences–Newark
FAS–NB   Faculty of Arts and Sciences–New Brunswick
GS–C   Graduate School–Camden
GS–N   Graduate School–Newark
GS–NB   Graduate School–New Brunswick
GSAPP   Graduate School of Applied and Professional Psychology
GSE   Graduate School of Education
IHHCPAR   Institute for Health, Health Care Policy, and Aging Research
IMCS   Institute of Marine and Coastal Sciences
IRC   Interdisciplinary Research Center
MGMCCR   Malcolm G. McLaren Center for Ceramic Research
MGSA   Mason Gross School of the Arts
NTI   National Transit Institute

RBS	Rutgers Business School: Newark and New Brunswick
RuCCS	Rutgers Center for Cognitive Science
SCILS	School of Communication, Information and Library Studies
SCJ	School of Criminal Justice
SE	School of Engineering
SL–C	School of Law–Camden
SL–N	School of Law–Newark
SMLR	School of Management and Labor Relations
SSW	School of Social Work
UC–C	University College–Camden
UC–N	University College–Newark
UC–NB	University College–New Brunswick
UMDNJ– RWJMS	University of Medicine and Dentistry of New Jersey– Robert Wood Johnson Medical School
UMDNJ– SOM	University of Medicine and Dentistry of New Jersey– School of Osteopathic Medicine
WIM	Waksman Institute of Microbiology

AFRICAN STUDIES 016

Program Offered: **Certificate in African Studies**
Director of Certificate Program: **Associate Professor Barbara Cooper,**
  202 Beck Hall, Livingston Campus (732/445-1194)

Participating Faculty

The certificate program in African studies is offered to students enrolled in graduate degree programs. The following graduate faculty members, identified more fully under degree program headings, are among those in charge of curricular arrangements for a certificate program in African studies.

A. Akinlabi, *Linguistics*
C. Braga-Pinto, *Spanish*
C.S. Brett-Smith, *Art History*
C. Brown, *History*
A. Busia, *English*
B. Cooper, *History*
L. Cronk, *Anthropology*
E. Dennis, *Cell and Developmental Biology*
B. Edwards, *English*
S. El-Shakhs, *Urban Planning and Policy Development*
J. Harris, *Anthropology*
A. Haugerud, *Anthropology*
D. Hodgson, *Anthropology*
A. Howard, *History*
D. Hughes, *Anthropology*
W. Johnson, *Anthropology*
Y. Kim, *Spanish*
D. Krueckeberg, *Urban Planning and Policy Development*
R. Larrier, *French*
B. Lewis, *Political Science*
S. Livingston, *History*
S. Martin-Marquez, *Spanish*
B. McCay, *Anthropology*
E. Ramsamy, *Urban Planning and Policy Development*
M. Robson, *Public Health*
P. Rothwell, *Spanish*
R. Schroeder, *Geography*
R. Serrano, *French*
M. Shafer, *Political Science*
J. Simon, *Plant Biology*
M. Turshen, *Urban Planning and Policy Development*

Certificate Program

The graduate certificate program in African studies by the Center for African Studies is designed for graduate students who would like to pursue a concentration in African studies as part of their regular graduate studies. Those who fulfill the requirements may be awarded a certificate in African studies upon completion of their degree. Some requirements for the certificate may be used to satisfy the student's own graduate degree requirements. These requirements are as follows:

1. Successful completion with a minimum grade-point average of 3.0 of the two African studies core courses, 16.016:501 Current Issues in the Study of Africa and 16:016:502 Interdisciplinary Research in African Studies;
2. Successful completion with a minimum grade-point average of 3.0 of at least three term courses on Africa from among approved graduate-level cognate courses (9 credits in total). At least one of these courses must be outside the student's degree program. Three of those credits may be accrued through independent study;
3. Proficiency in any African language or a relevant European language other than English demonstrated through completion of the second year of language study or by taking a language exam arranged through the Center for African Studies;
4. Completion of a major piece of writing on a topic related to Africa (master's thesis, dissertation, published article, or two substantial research papers).

Only students already admitted to a degree program in the Graduate School–New Brunswick may participate in the certificate program. Courses in African studies are offered by a number of graduate programs. Further information is available from the director of the graduate certificate program in African studies.

Graduate Courses

16:016:501. CURRENT ISSUES IN THE STUDY OF AFRICA (3)
Current interdisciplinary themes in African studies; guest faculty speakers from across the disciplines. Preparation of a bibliographic essay on interdisciplinary work in the student's chosen area.

16:016:502. INTERDISCIPLINARY RESEARCH IN AFRICAN STUDIES (3)
Preparation of prospectuses, grant applications, dissertation chapters, conference proposals and papers, and articles for publication. Students make an oral presentation of the proposed work, submit written drafts for class workshop, and provide commentary for their classmates.

16:016:503,504. INDEPENDENT STUDY: ISSUES IN AFRICAN STUDIES (3,3)
Advanced independent work in African area studies with African studies faculty members.

AGRICULTURAL ENGINEERING
  (See Bioresource Engineering 127)

ALCOHOL STUDIES 047

Program Offered: **Certificate in Alcohol Studies**
Director of the Certificate Program: **Professor Erich W. Labouvie,**
  Center of Alcohol Studies, Smithers Hall, Busch Campus
  (732/445-2518)

Participating Faculty

The following members and associate members of the graduate faculty, identified more fully under the subject headings indicated, are among those who participate in the certificate program in alcohol studies:

Marsha Bates, *Psychology*
Brenna Bry, *Psychology*
Elizabeth Epstein, *Psychology*
Valerie Johnson, *Sociology*
Erich W. Labouvie, *Psychology*
James Langenbucher, *Psychology*
Barbara S. McCrady, *Psychology*
Robert Pandina, *Psychology*
Larissa Pohorecky, *Pharmacology*
Arthur Tomie, *Psychology*
Helene Raskin White, *Sociology*

Certificate Program

Students with a special interest in any aspect of alcohol studies may pursue a special concentration in alcohol studies during their regular program of studies toward an advanced degree. Those who fulfill the requirements are awarded a certificate in alcohol studies upon completion of their degree. Many requirements for the certificate may be used to satisfy the student's graduate degree requirements. To earn a certificate in alcohol studies, students must

1. Complete 15 credits of course work in alcohol studies with a minimum grade average of *B*. Of the 15 credits, 9 credits must come from the course offerings described below. The remaining 6 credits also may be distributed among approved courses within the student's or from another discipline;
2. Submit an acceptable research or scholarly project in the field of alcohol studies, including, but not limited to, the master's thesis or doctoral dissertation;
3. Obtain approval from the director of the certificate program and the director of the student's graduate degree program. Only students matriculated in a degree program may participate in the certificate program, but others may take courses with permission of course instructors. Further information is available from the director;
4. Students in a graduate program with a clinical component, such as clinical psychology, are expected to acquire some applied clinical experience with alcoholic and alcohol-abusing clients. To fulfill this requirement, students must have the equivalent of two terms of a one-day-per-week practicum in an alcoholism-treatment setting. This is equivalent to 6 *N* credits. Three of these 6 credits may be applied to the overall 9-credit course requirement cited above. Nonclinical practica, such as criminal justice, are available to students in other disciplines through special arrangement, but this is not a requirement.

Graduate Courses

16:047:501. FOUNDATIONS IN ALCOHOL STUDIES: BIOLOGY, PSYCHOLOGY, AND SOCIOLOGY (3)
Bates, White
Provides a review of the essential information about alcohol's acute and chronic effects on biology and behavior and the sociology of its use and misuse.

16:047:502,503. INDEPENDENT STUDY OF ALCOHOL-RELATED ISSUES (3,3)
Opportunity to pursue an area of interest concerning alcohol use and abuse under the supervision and guidance of a faculty member.

16:047:601,602. PRACTICUM: CLINICAL TREATMENT OF ALCOHOLIC PATIENTS (N-BA,N-BA)
Prerequisite: Previous experience in direct patient care. Required for students in degree programs that provide specific training in counseling or psychotherapy, such as clinical psychology (Ph.D. or Psy.D.), counseling psychology, social work, or psychiatric nursing.

ANIMAL SCIENCES 067

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Henry John-Alder, Bartlett Hall, Cook Campus (732/932-3229)**

Members of the Graduate Faculty

Juan P. Advis, *Professor of Animal Sciences, CC; Ph.D., Southwestern Medical School (Dallas); D.V.M., Austral (Chile)*
Neuroendocrine control of reproduction in farm animals
Carol A. Bagnell, *Professor of Animal Sciences, CC; Ph.D., Medical College of Georgia*
Control of reproductive tissue growth; placental insufficiency
Rocco Carsia, *Associate Professor of Cell Biology, UMDNJ–SOM; Ph.D., Rutgers*
Adrenocortical cell biology
Wendie S. Cohick, *Associate Professor of Animal Sciences, CC; Ph.D., Cornell*
Mammary gland biology; endocrine regulation of cell growth

Julie M. Fagan, *Associate Professor of Animal Sciences, CC; Ph.D., Arizona*
Proteomics; biochemical regulation of food and alcohol intake; proteases
Harold Hafs, *Professor of Animal Sciences, CC; Ph.D., Cornell*
Physiology and endocrinology of reproduction; estrous synchronization, postpartum anestum, and puberty in cattle
Barry W. Jesse, *Associate Professor of Animal Sciences, CC; Ph.D., Michigan State*
Ruminant nutritional biochemistry and molecular biology
Henry B. John-Alder, *Professor of Animal Sciences, CC; Ph.D., California (Irvine)*
Comparative and environmental physiology and endocrinology
Larry S. Katz, *Associate Professor of Animal Sciences, CC; Ph.D., California (Davis)*
Endocrine regulation of reproductive behavior and wildlife damage management
Karyn Malinowski, *Professor of Animal Sciences and Dean of Outreach and Extension Programs, CC; Ph.D., Rutgers*
Equine endocrinology and physiology
Kenneth H. McKeever, *Associate Professor of Animal Sciences, CC; Ph.D., Arizona*
Equine exercise physiology; comparative cardiovascular and renal physiology
Sarah L. Ralston, *Associate Professor of Animal Sciences, CC; Ph.D., V.M.D., Pennsylvania*
Equine nutrition and behavior; effects of age on glucose, insulin, and mineral metabolism
Dipak K. Sarkar, *Distinguished Professor of Animal Sciences, Ph.D., Calcutta; D.Phil., Oxford*
Cellular and molecular neuroendocrinology
Michael V.K. Sukhdeo, *Associate Professor of Ecology and Evolution, CC; Ph.D., McGill*
Vertebrate parasitology
Mehmet Uzumcu, *Assistant Professor of Animal Science, CC; D.V.M., Ankara; Ph.D., Ohio State*
Ovary and testis development; endocrine disruptors in gonadal development
Malcolm Watford, *Associate Professor of Nutritional Sciences, CC; D.Phil., Oxford*
Regulation of glutamine metabolism
Michael Westendorf, *Associate Extension Specialist and Associate Professor of Animal Sciences, CC; Ph.D., Kentucky*
Ruminant nutrition; by-product utilization; waste management
James E. Wohlt, *Professor of Animal Sciences, CC; Ph.D., Illinois*
Nutritional requirements and management practices for livestock

Associate Member of the Graduate Faculty

Nadka Iv. Boyadjieva, *Assistant Research Professor of Animal Sciences, CC; M.D., Ph.D., D.Sci., Medical Academy (Bulgaria)*
Neuroendocrine control of immune system; effect of alcohol
Carey A. Williams, *Assistant Extension Specialist and Assistant Professor of Animal Sciences, CC; Ph.D., Virginia Polytechnic*
Equine nutrition and exercise; antioxidant supplementation and oxidative stress

Adjunct Members of the Graduate Faculty

William Baumbach, *Director of Drug R&D, X-Cell Medical, Inc.; Ph.D., Princeton*
Drug discovery; growth regulation; signal transduction
Kenneth Cummings, *Director, Animal Research and Technical Service, Church & Dwight Company; Ph.D., Purdue*
Nutritional physiology of animals in production systems
David W. Horohov, *Professor of Pathobiological Sciences, School of Veterinary Medicine, Louisiana State; Ph.D., Tennessee*
Effect of exercise stress on cytokines regulating equine immune responses
Limin Kung, Jr., *Professor of Animal and Food Sciences, Delaware; Ph.D., Michigan State*
Ruminant nutrition and microbiology
Linda Rhodes., *Senior Partner, AlcheraBio; V.M.D., Pennsylvania; Ph.D., Cornell*
Development of new animal health and productivity tools
Patricia A. Schoknecht., *Director, Center for Teaching, Learning, and Technology and Associate Professor of Biology, University of Richmond; Ph.D., Cornell*
Nutritional physiology in swine; neonatal growth
Jeffrey White, *Chief Scientific Officer, Predict, Inc.; Ph.D., SUNY (Stony Brook)*
Neuroendocrine control of growth and metabolism; drug discovery
Kathleen H. Young, *Associate Director of Neuroscience Discovery, Wyeth Research; Ph.D., Florida*
Neuroscience discovery

Programs

The graduate program in animal sciences offers M.S. and Ph.D. degrees as part of the large and interactive community of biological scientists at Rutgers and the Robert Wood Johnson Medical School of the University of Medicine and Dentistry of New Jersey. In addition to faculty from these universities, other members of the program come from research divisions of local pharmaceutical and agricultural industries. Major areas of research include

animal nutrition; by-product utilization; endocrinology of growth, lactation, and reproduction; equine science; exercise physiology; neuroendocrinology; and behavior.

Applicants are expected to have a strong background in biological sciences, including courses in general and organic chemistry and mathematics through calculus. The Graduate Record Examination (GRE) must be taken, and the subject test in biology is recommended but not required.

All students in the program must demonstrate competence in physiology, molecular biology and biochemistry, animal science, and statistics. There are no language or residency requirements.

The M.S. degree requires 30 credits, including at least 6 credits of research. A research thesis must be completed for this degree.

The Ph.D. degree requires 72 credits, including at least 24 credits of course work and 24 credits of research. Students must pass a comprehensive qualifying examination and complete a research dissertation.

Graduate Courses

16:067:501. ANIMAL BIOTECHNOLOGY (3)
Cohick. Required of all graduate students in animal sciences.
The theory underlying current techniques used in animal biotechnology and their applications to animal agriculture and the biomedical field. Ethical and social issues associated with animal biotechnology.

16:067:502. PHYSIOLOGY OF REPRODUCTION (3)
Advis. Prerequisites: Organic chemistry, vertebrate physiology.
Reproductive physiology of the higher vertebrates. The estrous, menstrual, and ovulation cycles; pregnancy; and parturition and lactation. Emphasis on growth areas in the field of reproductive physiology research.

16:067:506. PRINCIPLES OF INTEGRATIVE PHYSIOLOGY (3)
John-Alder. Prerequisite: Systems physiology or equivalent.
Organizing principles and design constraints of physiological processes, including homeostasis, size effects, symmorphosis, temperature, water balance, energy balance, and functional trade-offs.

16:067:507. RUMINANT NUTRITION (4)
Wohlt. Lec. 3 hrs., lab. 3 hrs. Prerequisite: An introductory course in biochemistry or nutrition.
Nutritional adequacy of feedstuffs as related to nutrient requirements and utilization, and metabolism in the ruminant animal for product development. Experimental designs in ruminal nutrition, anatomy and physiology of the digestive tract; rumen fermentation; water, lipid, carbohydrate, and protein metabolism; appetite; palatability; and control of feed intake.

16:067:508. EQUINE EXERCISE PHYSIOLOGY (3)
McKeever. Prerequisite: An introductory course in physiology.
Physiological and environmental factors associated with exercise in the horse.

16:067:510. NEUROENDOCRINOLOGY (3)
Advis, Sarkar
The role at organismic, cellular, and molecular levels of the hypothalamus and the pituitary gland in reproduction, stress, growth, biological rhythms, drug addiction, and immunity.

16:067:603,604. SPECIAL PROBLEMS IN ANIMAL SCIENCE (BA,BA)

16:067:611. TOPICS IN DOMESTIC ANIMAL NUTRITION (2)
Nutrient intake and metabolism and the partitioning of nutrients in pregnancy, lactation, and growth. Basic mechanisms and applications to production species.

16:067:612. RECENT ADVANCES IN ENDOCRINOLOGY (2)
Advis
Survey and analysis of current literature pertaining to endocrinology.

16:067:613. TOPICS IN ANIMAL GROWTH (2)
Growth in farm animals considered from a mathematical, biochemical, nutritional, and endocrinological basis.

16:067:614. CURRENT TOPICS IN METABOLIC REGULATION (2)
Jesse. Prerequisites: Biochemistry and a course in animal or poultry science.
Consideration of metabolic regulation discussed in reference to domestic livestock from a biochemical and molecular biological viewpoint. Discussions based on presentations by students and instructor using examples from current literature.

16:067:615. TOPICS IN ANIMAL BEHAVIOR (2)
Katz, Sukhdeo
Behavior of animals considered from endocrinological, evolutionary, and nutritional bases.

16:067:616. ANIMAL PHARMACEUTICALS: FROM DISCOVERY THROUGH MARKET (3)
Rhodes
The process of discovery, formulation, development (including safety and effectiveness), and registration of new animal drugs; overview of the worldwide animal health market.

16:067:693,694. SEMINAR IN ANIMAL SCIENCE (1,1)

16:067:701,702. RESEARCH IN ANIMAL SCIENCE (BA,BA)

ANTHROPOLOGY 070

Degree Programs Offered: **Master of Arts, Doctor of Philosophy**
Director of Graduate Program: **Professor Dorothy Hodgson,**
Adams Building, Douglass Campus (732/932-0633)

Members of the Graduate Faculty

Laura M. Ahearn, *Assistant Professor of Anthropology, FAS–NB; Ph.D., Michigan*
Linguistic anthropology, agency, gender, literacy, love letters; Nepal, South Asia
Susan Anton, *Associate Professor of Anthropology, FAS–NB; Ph.D., Michigan*
Evolution of genus **homo** *(origin of modern humans, Neanderthals,* **homo erectus**)*, hominid growth and development, dispersal patterns and process, functional morphology and osteology*
Myron J. Aronoff, *Professor of Political Science, FAS–NB; Ph.D., Manchester*
Political anthropology, complex societies; Israel, Middle East
Robert J. Blumenschine, *Professor of Anthropology, FAS–NB; Ph.D., California (Berkeley)*
Old-world prehistory, zooarchaeology, hominid ecology, and social organization; Africa
Susan M. Cachel, *Associate Professor of Anthropology, FAS–NB; Ph.D., Chicago*
Physical anthropology, primate evolution, morphology
Chi-hua Chiu, *Assistant Professor of Anthropology and Genetics, FAS–NB; Ph.D., Wayne State*
Evolutionary genetics of human and nonhuman primates; molecular evolution of Hox genes
Sheila C. Cosminsky, *Associate Professor of Sociology and Anthropology, FAS–C; Ph.D., Brandeis*
Cultural and medical anthropology, ethnic relations; Mesoamerica, Africa
Lee Cronk, *Associate Professor of Anthropology, FAS–NB; Ph.D., Northwestern*
Human behavioral ecology and human evolutionary ecology; Africa and Caribbean
Craig S. Feibel, *Associate Professor of Anthropology, FAS–NB; Ph.D., Utah*
Environment and ecology in human evolution; rift valley sedimentation
Robin Fox, *University Professor of Anthropology, FAS–NB; Ph.D., London*
Kinship and marriage, evolution of behavior; North America, Northwestern Europe
Peter J. Guarnaccia, *Professor of Human Ecology, CC; Ph.D., Connecticut*
Medical anthropology, nutritional anthropology, Hispanics in the United States, cross-cultural psychiatry, anthropology and epidemiology; Mexico
John W.K. Harris, *Chairperson and Professor of Anthropology, FAS–NB; Ph.D., California (Berkeley)*
Paleoanthropology, old-world prehistory, lithic analysis, method and theory; Africa
Angelique Haugerud, *Associate Professor of Anthropology, FAS–NB; Ph.D., Northwestern*
Economic and political anthropology; agrarian ecology; land tenure; social change and development; Africa

Dorothy L. Hodgson, *Associate Professor of Anthropology, FAS–NB; Ph.D., Michigan (Ann Arbor)*
Gender, ethnicity, development, history, cultural politics, indigenous rights, social movements; East Africa, West Africa

David McDermott Hughes, *Assistant Professor of Human Ecology, CC; Ph.D., California (Berkeley)*
Frontiers, colonialism, environment and development, Southern Africa

Walton R. Johnson, *Associate Professor of Africana Studies, FAS–NB; Ph.D., London*
Cultural anthropology, race relations, religion; Southern Africa

Uli H. Linke, *Associate Professor of Anthropology, FAS–NB; Ph.D., California (Berkeley)*
Cultural anthropology; body politics; gender and difference; memory, history, and violence; European societies (Germany)

Bonnie J. McCay, *Board of Governors Professor of Anthropology and Ecology, CC; Ph.D., Columbia*
Ecological and economic anthropology; fisheries, common property; North Atlantic

Michael Moffatt, *Professor of Anthropology, FAS–NB; Ph.D., Chicago*
Religion; diasporic Hinduism; ethnographic practice; South Asia; caste

George E.B. Morren, Jr., *Professor of Human Ecology, CC; Ph.D., Columbia*
Human ecology, evolutionary theory, environment; Oceania, United States

Ryne Palombit, *Associate Professor of Anthropology, FAS–NB; Ph.D., California (Davis)*
Evolution and ecology of primate social behavior, male-female relationships, gibbons, baboons, and saki and titi monkeys

Ana Y. Ramos-Zayas, *Assistant Professor of Puerto Rican and Hispanic Caribbean Studies, FAS–NB; Ph.D., Columbia*
Cultural/social anthropology; nationalism, ethnic, and class identities; racialization processes; Latinos in the United States

Louisa Schein, *Associate Professor of Anthropology, FAS–NB; Ph.D., California (Berkeley)*
Cultural politics, ethnicity, gender, transnational issues; China

Carmel Schrire, *Professor of Anthropology, FAS–NB; Ph.D., Australian National*
Prehistory, historical archaeology, human ecology, hunter-gatherers; Australia, Southern Africa

Warren Shapiro, *Professor of Anthropology, FAS–NB; Ph.D., Australian National*
Social theory, history of anthropology, kinship, religion, ethnographic study of human nature; aboriginal Australia

H. Dieter Steklis, *Professor of Anthropology, FAS–NB; Ph.D., California (Berkeley)*
Primatology, mountain gorilla conservation, biology of behavior; central-East Africa

Lionel Tiger, *Charles Darwin Professor of Anthropology, FAS–NB; Ph.D., London*
Political structures, sex roles, ethology, kibbutzim; Israel

Robert Trivers, *Professor of Anthropology and Biological Sciences, FAS–NB; Ph.D., Harvard*
Principles underlying social evolution, evolutionary genetics

Andrew P. Vayda, *Professor Emeritus of Anthropology and Ecology, CC; Ph.D., Columbia*
Human ecology, methodology and explanation, ecological and evolutionary theory; Southeast Asia, New Guinea, Polynesia

Associate Members of the Graduate Faculty

Myra Bluebond-Langner, *Professor of Anthropology, FAS–C; Ph.D., Illinois*
Death, dying, bereavement, chronic illness; children and families

Anne-Marie Cantwell, *Associate Professor of Anthropology, FAS–N; Ph.D., New York*
North American archaeology, prehistoric trade and ideology; complex societies

R. Brian Ferguson, *Professor of Anthropology, FAS–N, Ph.D., Columbia*
War, policing, contemporary "ethnic conflict," state-tribe interaction, historical ecology; lowland South America, Puerto Rico

Alex Hinton, *Assistant Professor of Anthropology, FAS–N; Ph.D., Emory*
Violence, genocide, globalization, emotion, and identity; Cambodia; Southeast Asia

Chün-fang Yü, *Professor of Religion, FAS–NB; Ph.D., Columbia*
Culture and religion, Buddhism; China

Programs

Requirements for the Ph.D. program include 48 approved course credits and 24 research credits. Within the 48 credits, all students must take the introductory 16:070:501 Proseminar in Anthropology. Students in the human evolutionary studies track also must take 01:960:401 Basic Statistics for Research or an equivalent, and either 16:070:508 Evolutionary Theory and Processes or 16:070:560 Natural Selection and Social Theory. Students in the cultural track also must take 16:070:505 History of Anthropological Theory and 16:070:506 Research Design and Methods in Social/Cultural Anthropology. Students in the environmental anthropology track also must take 16:070:543 Ecological Anthropology and 16:070:506 Research Design and Methods in Social/Cultural Anthropology

or another research-methods course that is approved by his or her adviser. In addition, these students are encouraged to take 16:070:544 Environmental Anthropology in a Changing World and 16:070:526 Urban Ethnography. They also must meet the requirements of the interdisciplinary Certificate Program in Human Dimensions of Environmental Change.

All second-year students are expected to present a scholarly paper at a day-long retreat. Ph.D. students also are expected to prepare three "field statements," textual summaries, and extensive bibliographies of three areas of research broader than, but related to, their dissertation topic. After completing their 48 credits of course work and their field statements, students prepare a dissertation research proposal on which they must pass an oral-proposal defense. When the dissertation is completed, it is evaluated in an oral-dissertation defense.

Students who enter the Ph.D. program may earn an M.A. along the way by applying for one after completion of at least 30 credits and completion of the three field statements. Students who enter the master's program are expected to take the same required courses listed above for the Ph.D. program. They may either complete a written comprehensive exam after 30 credits, or write a 6-credit master's thesis (with an oral exam) after 24 credits of course work. Students who enter the master's program may then apply to enter the Ph.D. program. A master of philosophy degree also is available to students on their way to a Ph.D., but not as a terminal degree.

Students are urged to complete their Ph.D. within five years. While there is no formal fieldwork requirement, most students in both evolutionary and cultural anthropology find fieldwork necessary for a doctoral degree. There is no specific language requirement, but students are expected to acquire any languages necessary for successful completion of their research . Examples would include languages a student might need for field projects or library research. There is no residency requirement.

Selected courses may be taken in other programs, such as geological sciences, history, political science, women's and gender studies, psychology, sociology, urban planning, ecology, nutrition, geography, and computer science.

Graduate Courses

16:070:501. PROSEMINAR IN ANTHROPOLOGY I (3)
Presentations in areas of current faculty research.

16:070:502. PROSEMINAR IN ANTHROPOLOGY II (3)
Basic overview of the central concepts, theories, resources, and methods fundamental to cultural anthropology, human ecology, physical anthropology, and archaeology.

16:070:503. SOCIAL/CULTURAL ANTHROPOLOGY (3)
Social anthropology past and present; kinds of explanation, ethnoscience, methods and fieldwork, new directions, process, transaction and symbolic interaction, modern role theory, and networks.

16:070:504. SOCIAL ORGANIZATION (3)
Examination of problems in social structure and organization with special reference to descent and alliance theory, kinship semantics and formal analysis, and evolution of social systems.

16:070:505. HISTORY OF ANTHROPOLOGICAL THEORY (3)
Origin and development of anthropology; surveying the central ideas of major figures from the 17th century to the present.

16:070:506. RESEARCH DESIGN AND METHODS IN SOCIAL/CULTURAL ANTHROPOLOGY (3)
Survey and critical evaluation of methods in current anthropology, using original research as data.

16:070:508. EVOLUTIONARY THEORY AND PROCESSES (3)
Natural selection, adaptation, evolutionary genetics, speciation, extinction, adaptive radiation, and macroevolution with special emphasis on human and nonhuman primate evolution.

16:070:509. KINSHIP IN NATURE AND CULTURE (3)
Examination of the anthropological orthodoxy that kinship systems are a property of culture and hence of human society; systematic examination of the role of kinship in the lives of other species, particularly the higher primates. The adaptational significance of human innovations.

16:070:510. SOCIAL IMPLICATIONS OF GENDER DIFFERENCES (3)
Consideration of the results of the interaction between the biological fact of gender differences and the varieties of cultural response to and interpretation of these differences.

16:070:511. ANTHROPOLOGY OF GENDER (3)
Uses recent ethnographic and ethnological studies of women to appraise such anthropological assumptions as the homogeneity of simple societies, the harmony and stability of large or small societies, the primacy of the family, and the validity of ethnographic data.

16:070:512. COGNITIVE ANTHROPOLOGY (3)
Theoretical and methodological issues in the study of culture and cognition.

16:070:513. LANGUAGE DEVELOPMENT (3)
Animal communication; theories of the origin of language; biological basis of language. Cross-cultural comparison of language development in children and language universals.

16:070:514. LANGUAGE AS SOCIAL ACTION (3)
Cultural implications of language and its use. Relations between language and culture, language and cognition, language and social group.

16:070:516. SEXUALITY IN A CROSS-CULTURAL PERSPECTIVE (3)
Ethnographic issues in study of sexuality; major approaches; construction of sexuality, eroticism, and gender in wide range of cultures; relation of erotic culture to wider social order, history.

16:070:517. PSYCHOLOGICAL ANTHROPOLOGY (3)
Study of interrelations among personality and culture and social structure. Emphasis on the comparative perspective.

16:070:518. CORPORATE AND PERSONAL VIOLENCE (3)
Analysis of aggression and violence as features of individual and group behavior. Biological, evolutionary, sociological, and philosophical approaches.

16:070:519. POLITICAL ORGANIZATION (3)
Explorations of political organization of human societies at all stages of sociocultural development, beginning with hunter-gatherers and concluding with modern industrial state systems.

16:070:520. ANALYSIS OF STATE SYSTEMS (3)
The anthropological approach to the analysis of nation-states with special reference to boundary mechanisms, value systems, and the political control of everyday activities.

16:070:521. ANTHROPOLOGY OF INDUSTRIAL SOCIETY (3)
Effects of the industrial system on kinship behavior, socialization of the young, the use of time, ethnicity and kinship interests, and "alienation." Limited, focused research project by the student.

16:070:522. ANTHROPOLOGY OF RELIGION (3)
Religion in the known cultures of the world, with special attention to ritual and myth. Detailed examination of particular ethnographic sources. The link between religious universals and theories of human nature.

16:070:523. CULTURE AND AGING (3)
Human aging in life course perspective. Focus on cross-cultural and intracultural diversity.

16:070:524,525. WORLD ETHNOGRAPHIC AREAS I,II (3,3)
Study of selected ethnographic areas such as Africa, Southeast Asia, India, or North America; cross-cultural analysis within an area. General theoretical and methodological issues as well as those unique to the particular area.

16:070:526. URBAN ETHNOGRAPHY (3)
Classic and contemporary urban ethnographies of the United States and elsewhere. Urban methods, construction of "the field," and epistemological concerns. Modernity and global cities. Space, race, and class. Representations of urbanism.

16:070:527. (F) THE ETHNOLOGY OF INEQUALITY: RACE, CLASS, AND ETHNICITY (3)
Survey of anthropological literature on the relationships among race, class, and ethnicity. Ethnographic methods and the comparative approach to the study of hegemony, resistance, and conflict among groups defined as "racial" or "ethnic."

16:070:528. EXPLANATION IN ANTHROPOLOGY (3)
Analysis of modes of explanation used in anthropological studies, with consideration of such issues as holism versus individualism; essentialism versus nominalism; action explanations and other explanations; generalization and particularism; and the problem of other cultures and other periods.

16:070:529. RACIALIZATION, IMMIGRATION, AND THE POLITICS OF CITIZENSHIP (3)
Relationship of citizenship to processes of racial formation in modern nation states. Topics include national histories of citizenship; (im)migration and globalization; regimes of difference; citizen-subjects; education; patriotism; multiculturalism; language politics.

16:070:530. PROBLEMS IN SOCIAL ANTHROPOLOGY (3)
For graduate students wishing to pursue advanced work supplementary to that provided in formal courses. Program of reading and conferences arranged by professor in charge.

16:070:531. PROBLEMS IN COMPARATIVE ANALYSIS (3)
For graduate students wishing to pursue advanced work in areas not provided for in formal courses. Conferences, reading, and empirical work arranged in consultation with the professor in charge.

16:070:532. PROBLEMS IN ETHNOGRAPHY (3)
For graduate students wishing to pursue advanced work in areas not provided for in formal courses. Conferences, reading, and empirical work arranged in consultation with the professor in charge.

16:070:543. ECOLOGICAL ANTHROPOLOGY (3)
The ecological approach in anthropology. Consideration of theory, method, and data analysis in ecological studies.

16:070:544. ENVIRONMENTAL ANTHROPOLOGY IN A CHANGING WORLD (3)
Methods for the analysis of current socioeconomic, health, and environmental problems involving interactions between people and their environment.

16:070:545. ANTHROPOLOGY OF DEVELOPMENT (3)
Economic development and social change in third-world and advanced industrial societies. Theories of social change applied to areas such as education, urban planning, and social welfare.

16:070:546. MEDICAL ANTHROPOLOGY (3)
Examination of sociocultural factors influencing health and illness and the impact of social and cultural changes on disease patterns and health care systems. Includes ethnographic studies of systems of illness causation, prevention, diagnosis, and treatment.

16:070:547. PARTICIPATORY PLANNING IN APPLIED ANTHROPOLOGY (3)
Role of applied anthropology in facilitating broad public participation in development projects and other kinds of change initiatives; ethics and professional practice.

16:070:548. TRANSNATIONALISM AND GLOBALIZATION (3)
Global flows and structures, modernity, colonialism, postcoloniality, global capitalism, development, political activism, diaspora, migration, nationalism and citizenship, race and sexuality, transnational culture and media, reconfigurations of space, territory and locality.

16:070:549. CULTURE AND CAPITALISM (3)
Explores historical and contemporary efforts to analyze the relationship between culture and capitalism. Relevant theories and critical readings of current ethnographies. Topics include commoditization, modernity, colonialism, postcoloniality, production and reproduction, and social differences.

16:070:550. ECONOMIC ANTHROPOLOGY (3)
Survey of theories and methods in economic anthropology.

16:070:551. MARITIME ANTHROPOLOGY (3)
Prerequisite: Course in anthropological theory.
An advanced course in sociocultural, economic, and ecological anthropology focused on the study of fishing and other maritime communities and problems concerning human relationships to natural resources.

16:070:552. SEMINAR IN ECOLOGICAL ANTHROPOLOGY (3)
Interrelations of ecological and socioeconomic changes as an interdisciplinary problem area.

16:070:553. PROBLEMS IN HUMAN ECOLOGY I (3)
For graduate students wishing to pursue advanced work in areas not provided for in formal courses. Conferences, reading, and laboratory work arranged in consultation with the professor in charge.

16:070:554. PROBLEMS IN HUMAN ECOLOGY II (3)
For graduate students wishing to pursue advanced work in areas not provided for in formal courses. Conferences, reading, and laboratory work arranged in consultation with the professor in charge.

16:070:558. EVOLUTION OF THE HOMINIDAE (3)
The fossil Old-World higher primates; the Miocene fossil apes; problems of when, where, and why hominids first appeared; the australopithecines of Plio/Pleistocene Africa; early genus *Homo; Homo erectus;* Neanderthals; the appearance of anatomically modern man; Paleolithic cultures.

16:070:559. EVOLUTION OF BEHAVIOR (3)
Consideration of human and primate behavior from an evolutionary perspective. Topics include aggression, territorial behavior, sexuality and mating systems, socialization, and sex roles in primate society.

16:070:560. NATURAL SELECTION AND SOCIAL THEORY (3)
Recent papers on key topics in social evolution, such as female choice, symmetry, parasites, virulence, kinship, homosexuality, reciprocal altruism, and self-deception. Special emphasis on human data.

16:070:563. THE BIOLOGY OF SOCIAL BONDS (3)
The dynamics of basic social bonds, such as the mother-child bond, the mating bond, the bond between older and younger males, and the sibling bond, analyzed in terms of their evolution and of their significance for micro and macro social structures.

16:070:564. PROBLEMS IN THE BIOLOGY OF SOCIAL RELATIONS (3)
The place of biology in the social sciences, relevance of the comparative sociology of animal societies; the phylogeny of behavior; special problems of aggression, territory, sexual and parental relationships, and language.

16:070:566. HUMAN OSTEOLOGY (3)
Lec. 2 hrs., lab. 1 hr.
Examination of primate morphology, with emphasis on the evolution of human morphological adaptations.

16:070:567. HUMAN VARIATION (3)
Variation in body size, shape. Structural morphology, pigmentation, and biochemistry among living humans; climatic adaptation, disease, and human evolution; population origins through migration or local continuity through evolutionary time.

16:070:568. PRIMATE ECOLOGY AND SOCIAL BEHAVIOR (3)
Behavior of the nonhuman primates, emphasizing the relationship between ecology and social organization; the structure of social groups; and the development of behavior.

16:070:569. SEXUAL DIFFERENCES AND SEXUAL SELECTION IN PRIMATES (3)
Methods, findings, theoretical developments of sexual selection studies in primates. Evolution of sex differences in behavior, sexuality, and morphology. Focus on primates in the comparative framework of studies of other organisms.

16:070:570. HOMINID TAXONOMY AND SYSTEMATICS (3)
Implications of the existence of sympatric species; limits to similarity imposed by the coexistence of competing species; controversies surrounding the establishment of taxa; phylogenetic reconstructions.

16:070:571. PRIMATE EVOLUTION AND RADIATIONS (3)
Exploration of primate history in terms of evolutionary radiations. Emphasis on entrance to and radiation within new adaptive zones and the change of these zones through time, using morphological and paleoecological information.

16:070:572. BIOLOGY OF HUMAN BEHAVIOR (3)
Current uses and philosophical-historical bases of biological explanations of human behavior in social sciences. Role of animal behavior, cross-cultural, and genetic-neurohormonal data in the analysis of human social behavior.

16:070:573. PROBLEMS IN BIOLOGICAL ANTHROPOLOGY (3)
For graduate students wishing to pursue advanced work in areas not provided for in formal courses. Conferences, reading, and laboratory work arranged in consultation with the professor in charge.

16:070:574. METHODS IN FIELD PRIMATOLOGY (3)
Current techniques for quantifying and sampling behavior in the field; specialized subjects include habitat description, phenology, audio recording, experimental design (playbacks), capture/immobilization, hormonal and DNA sampling, GPS/GIS, equipment.

16:070:578. OLD WORLD PREHISTORY (3)
Key data and current interpretive models concerning the archaeology of hominid adaptations from earliest times through the Neolithic in the Old World.

16:070:579. NEW WORLD PREHISTORY (3)
Key data and current interpretive models concerning the form, stability, and change of cultures throughout the pre-Columbian New World.

16:070:580. RESEARCH METHODS AND THEORY IN ARCHAEOLOGY (3)
Conceptual bases and assumptions used in the formulation of research designs and the interpretation of research results; examination of fieldwork problems and techniques, with emphasis on the problems of observation, use of documentary sources, surveying and excavation, and use of quantitative data.

16:070:581. HISTORICAL DEVELOPMENT OF ARCHAEOLOGY (3)
Origins of classical and Near Eastern archaeology in Greek
and Roman philosophy, and developments from the revival
of classical learning in the Renaissance. Development of prehistoric
archaeology and New World archaeology as a subfield of general
anthropology.

16:070:582. PALEOECOLOGY AND ARCHAEOLOGY (3)
Methods of environmental reconstruction. Emphasis on the evolu-
tion of subsistence economies, with special attention to the origins
of animal and plant domestication.

16:070:583. ORIGINS OF AGRICULTURE (3)
Archaeological, zoological, botanical, geographical, and ethno-
graphic data relating to ancient and modern hunter-gatherers
and farmers used to compare and contrast their demography,
material culture, and economy, so that the origins of settled life
can be seen.

16:070:584. THE BUILT ENVIRONMENT (3)
 Prerequisite: One year of graduate work in anthropology.
Anthropological principles applied to the planning process in con-
temporary society. Emphasis on political, environmental, techno-
logical, and biological planned change.

16:070:585,586. PROBLEMS IN ARCHAEOLOGY (3,3)
For graduate students wishing to pursue advanced work in areas
not provided for in formal courses. Conferences, reading, and labo-
ratory work arranged in consultation with the professor in charge.

16:070:587. FIELD STUDY IN ARCHAEOLOGY (3)
 Minimum of 6 to 10 weeks at field location. Course may be repeated with permis -
 sion of program director.
Supervised participation in fieldwork with instruction in excava-
tion methods and practices. Personnel and field project location
vary from year to year.
Fees: tuition, transportation to site, and room and board.

16:070:602. SEMINAR IN SOCIAL THEORY (3)
 Prerequisite: 18 credits in graduate social science courses or permission
 of instructor.
The intellectual history and philosophy of social science; explo-
ration of the origins of the social and behavioral sciences in the
western humanistic tradition.

16:070:626. VISUAL ANTHROPOLOGY (3)
Study, use, and production of anthropological and ethnographic
photographs, films, and videos for research and communication;
study of human behavior through visual media.

16:070:701,702. RESEARCH IN ANTHROPOLOGY (BA,BA)

ART HISTORY 082

Degree Programs Offered: **Master of Arts, Doctor of Philosophy**
Certificate Programs Offered: **Certificate in Curatorial Studies,**
 Certificate in Historical Preservation
Director of Graduate Program: **Professor Catherine Puglisi,**
 207 Voorhees Hall, College Avenue Campus
 (732 ⁄ 932-7041, ext. 16)

Members of the Graduate Faculty

Matthew Baigell, *Professor Emeritus of Art History, FAS–NB; Ph.D.,*
 Pennsylvania
 American art
Olga Berendsen, *Associate Professor Emerita of Art History, FAS–NB;*
 Ph.D., New York
 Baroque
Sarah Brett-Smith, *Associate Professor of Art History, FAS–NB; Ph.D., Yale*
 African
Martin Eidelberg, *Professor Emeritus of Art History, FAS–NB; Ph.D., Princeton*
 Baroque and rococo; modern decorative arts
Rona Goffen, *Board of Governors Professor of Art History, FAS–NB;*
 Ph.D., Columbia
 Italian Renaissance

Archer St. Clair Harvey, *Professor of Art History, FAS–NB; Ph.D., Princeton*
 Early Christian and Byzantine; historic preservation
Angela Howard, *Professor of Art History, FAS–NB; Ph.D., New York*
 East Asian
John F. Kenfield III, *Associate Professor of Art History, FAS–NB; Ph.D., Princeton*
 Greek and Roman
Tod A. Marder, *Professor of Art History, FAS–NB; Ph.D., Columbia*
 Renaissance; baroque; historic preservation
Joan M. Marter, *Professor of Art History, FAS–NB; Ph.D., Delaware*
 Modern art; 20th-century art; gender studies; curatorial studies
Sarah E. Blake McHam, *Professor of Art History, FAS–NB; Ph.D., New York*
 Italian Renaissance
Elizabeth Parker McLachlan, *Associate Professor Emerita of Art History,*
 FAS–NB; Ph.D., Courtauld Institute (London)
 Medieval
Catherine R. Puglisi, *Professor of Art History, FAS–NB; Ph.D., New York*
 Baroque
Jocelyn P. Small, *Professor of Art History; Ph.D., Princeton*
 Classical art and archaeology; iconography; Etruscology
Jack J. Spector, *Professor of Art History, FAS–NB; Ph.D., Columbia*
 Modern art and theory of criticism
Carla Yanni, *Associate Professor of Art History, FAS–NB;*
 Ph.D., Pennsylvania
 Nineteenth- and 20th-century architecture; historic preservation

Associate Members of the Graduate Faculty

Wendy Bellion, *Assistant Professor of Art History, FAS–NB; Ph.D., Northwestern*
 American art
Phillip D. Cate, *Supervisor of Curatorial and Academic Affairs at the Zimmerli*
 Art Museum; M.A., Arizona State
 History of the print; French 19th-century graphics
Jane Sharp, *Assistant Professor of Art History, FAS–NB; Ph.D., Yale*
 Nineteenth- and 20th-century European art; Russian

Programs

The faculty in art history offers degree programs leading to the
M.A. and Ph.D. degrees in the major fields of Western art, sub-
Saharan African art, and East Asian art. The faculty also offers
programs leading to a certificate in curatorial studies and in histor-
ical preservation. Both degree programs are designed to provide a
well-rounded and comprehensive knowledge of the major histori-
cal periods. The Ph.D. program, in addition, allows for specializa-
tion in one of the major fields.

 Applicants should have a strong liberal arts background, with a
minimum of six art history courses as prerequisite for admission.
Students may be asked to make up deficiencies prior to or in the
first year of the graduate curriculum by taking undergraduate
courses for graduate credit, auditing undergraduate classes, or
through supervised readings. Although not a prerequisite, reading
proficiency in one foreign language must be demonstrated within
the first year of the program.

 Requirements for the Ph.D. include 14 courses, worth
48 credits; a qualifying examination in one of the major art histori-
cal periods; and acceptance of the dissertation. In addition, stu-
dents must have a reading knowledge of German and one other
foreign language. One proficiency examination must be taken by
the second term of study. After the student completes eight
courses, the faculty will review his or her work to determine if the
student will be allowed to continue for the Ph.D.

 The M.A. program is designed for those who do not plan to pur-
sue the Ph.D. and for those pursuing the certificate in curatorial
studies or the certificate in historical preservation. Requirements
include 10 courses (30 credits), one foreign language, a master's
essay, and a comprehensive examination.

 The curatorial studies certificate, which is awarded separately,
requires one course in curatorial training and three curatorial
internships (12 *E* credits total). Students must take at least one
exhibition seminar, for which they earn 3 credits toward their
degree. Students in the M.A. and Ph.D. programs are eligible to
pursue a curatorial studies certificate.

 Similarly, students in the M.A. and Ph.D. programs are eligible
to pursue a certificate in historical preservation, which is also
awarded separately, and requires two core courses, two elective
courses, and an approved internship (15 *E* credits total). Electives
are chosen from an approved list.

There are no residence requirements for either degree program. Students who have earned an M.A. degree elsewhere are welcome to apply for admission to the Ph.D. program. The curriculum is flexible and allows students to explore interests in such areas as African studies, American studies, Asian studies, classics, archaeology, gender studies, medieval studies, renaissance studies, baroque studies, Russian and Slavic studies, and theory and criticism.

Further information on program requirements may be obtained from the art history graduate office in Voorhees Hall or online at *http://arthistory.rutgers.edu.*

Graduate Courses

16:082:503,504. INDIVIDUAL STUDIES IN ART HISTORY (BA,BA)

16:082:506. APPROACHES TO ART HISTORY (3)
Spector
History of art history and explanation of the basic methodologies (iconography, connoisseurship). Recent challenges from outside the field—political, psychological, semiotic.

16:082:509. AFRICAN ART AND ARCHITECTURE (3)
Brett-Smith
Survey of the art history of West Africa. Examines the different theoretical and practical models that have been used to look at African art history, their origins in the "discovery" of African art, and their relationship to multiculturalism and current attempts to study the "other."

16:082:511. ARCHAIC GREEK ART (3)
Kenfield
Examination of the origins and early development of Greek architecture, sculpture, and painting.

16:082:514. HELLENISTIC PAINTING AND SCULPTURE (3)
Kenfield
Examination of the development of Hellenistic sculpture and painting from its origins in the late fifth century B.C.

16:082:515. ETRUSCAN ART (3)
Small
Focuses on the development of an independent culture within a world increasingly dominated by Greece and Rome.

16:082:517. ANCIENT MOSAICS (3)
Kenfield
Examination of mosaic painting from its origins through the early Byzantine period.

16:082:521. ART OF LATE ANTIQUITY (3)
Harvey
Art and architecture of the Mediterranean world, third to seventh centuries. Emphasis on religious and political contexts and theories of stylistic and iconographic development.

16:082:524. CHRISTIAN ICONOGRAPHY (3)
Harvey
The origin and development of Christian imagery. Emphasis on methods of iconographical research.

16:082:528. MODERN ARCHITECTURE (3)
Yanni
Major architects and theorists in Europe and the Americas from the 18th century to the present. Emphasis on reading of theoretical texts and analysis of the most important architects and buildings from Laugier to the present.

16:082:529. DESIGN OF CITIES (3)
Yanni
History of urban design in Europe and the Americas from the 17th century to the present, with emphasis on major cities, their principal planning episodes, and urban planning theory and practice in cultural and social perspectives.

16:082:532. ITALIAN PAINTING IN THE AGE OF DANTE (3)
Goffen
Style, patronage, and iconography in painting from 1250–1400, emphasizing the work of such masters as Giotto, Duccio, Simone Martini, and the Lorenzetti.

16:082:536. RENAISSANCE ARCHITECTURE (3)
Marder
Architecture in Italy from 1400 to 1600, including issues of form, symbol, meaning, and intention. The influence of engineering, urban planning, military architecture, garden design, and theory as well as practice addressed.

16:082:537. EARLY BAROQUE PAINTING IN ITALY (3)
Puglisi
Painting in Rome ca. 1600, focusing on the stylistic innovations and legacy of the Carracci and Caravaggio in the context of contemporary artistic trends, patronage, and theory.

16:082:538. BERNINI (3)
Marder, Puglisi
Consideration of Bernini's career as the universal artistic genius of the Roman baroque. Sculpture, architecture, and painting and their contexts considered.

16:082:539. VELAZQUEZ AND BAROQUE PAINTING IN SPAIN (3)
Puglisi
Major achievements of the 17th-century painter and his impact on Spanish baroque painting.

16:082:540. ENGLISH ARCHITECTURE (3)
Marder
Arrival and development of classical architecture in England from 1500 to 1780. Emphasis on individual styles, urban schemes, and cultural contexts.

16:082:541. SEVENTEENTH-CENTURY NORTHERN EUROPEAN PAINTING (3)
Study of major stylistic and thematic currents of the baroque as interpreted in the Netherlands, Flanders, and France.

16:082:543. DUTCH GENRE PAINTING IN THE 17TH CENTURY (3)
Recent interpretations of the themes and pictorial "realism" of Dutch 17th-century genre painting and its antecedents. Artists include Frans Hals, Gerard Dou, Gerard Terborch, Johannes Vermeer, and Jan Steen.

16:082:547. BAROQUE ARCHITECTURE (3)
Marder
Emphasizing 17th-century Rome, the great architects Bernini, Borromini, and Pietra da Cortona discussed in depth. Issues of urbanism, the contributions of the Piedmontesi architects, and 18th-century architecture examined.

16:082:548. PRINTS AND PRINTMAKERS (3)
History of printmaking, emphasizing the processes and major artists involved.

16:082:551. ROMANTIC ART (3)
Spector
Nature, sources, and influences of 19th-century French romanticism (Gros, Gericault, Delacroix, Ingres), with some consideration of literature (Hugo, Gautier, Baudelaire).

16:082:552. DAWN OF ABSTRACTION (3)
Spector
Analysis of the theories of critics and the practices of painters and sculptors in Europe from 1900 to 1920 in order to understand why and how abstraction emerged and evolved.

16:082:553. SURREALISM (3)
Spector
History of surrealist painting and writing as antimodernist avant-garde concerned with psychological and political questions.

16:082:554. NINETEENTH-CENTURY AMERICAN LANDSCAPE PAINTING (3)
Bellion
Consideration of various movements, including the Hudson River School, luminism, American Barbizon, and impressionist painting as well as landscapes of the west.

16:082:555. NINETEENTH-CENTURY REALISM (3)
Spector
Emphasis on social and political themes in French art (Courbet, Manet) and literature (Balzac, Flaubert, Zola).

16:082:556. AMERICAN ART, 1900–1960 (3)
Bellion
Consideration of various movements, including the ashcan school, early modernism, precisionism, regionalism, social realism, and abstract expressionism.

16:082:557. FRENCH 18TH-CENTURY PAINTING (3)
Study of rococo, neoclassicism, and early romanticism from the reign of Louis XIV to Napoleon. Focus on the emergence of modern subject matter.

16:082:559. PICASSO (3)
Spector
Covers the full range of Picasso's artistic creations and also his writings, political involvement, and personality.

16:082:561. POSTIMPRESSIONISM (3)
Developments between impressionism and fauvism mainly in France (Cezanne, Gauguin, Van Gogh, Seurat). Discussions include nabis symbolism and art nouveau.

16:082:563. CURATORIAL TRAINING I (E3)
History, philosophy, organizational structures, and operations of the museum as a sociocultural institution.

16:082:571. GERMAN EXPRESSIONISM (3)
Marter, Spector
German expressionist art in the context of 19th- and 20th-century European modernism. Literary, philosophical, and psychological aspects considered.

16:082:574. FUTURISM (3)
Marter
Impact of futurist art and theory in Italy, France, Russia, Germany, and Great Britain. Futurist manifestos and their importance to modernism.

16:082:577. MODERN SCULPTURE (3)
Marter
Major developments in European and American sculpture from 1880 to 1960. Beginning with Auguste Rodin and his impact on early modernists, and including sculpture produced in France, Germany, Italy, and the United States.

16:082:580. CUBISM AND GEOMETRIC ABSTRACTION (3)
Marter
Origins of cubism and links to cultural trends and scientific developments of the period. In addition to analytical and synthetic cubism, Russian constructivism, de Stijl, bauhaus art, and international constructivism examined.

16:082:581. ITALIAN BAROQUE SCULPTURE (3)
Marder, Puglisi
Major sculptors and trends in 17th-century Italian sculpture.

16:082:582. SEMINAR: EAST ASIAN BIBLIOGRAPHY AND METHODS (3)
Howard. Required of students majoring in Asian studies.
Important sources for researching Chinese art.

16:082:583. TOPICS IN EAST ASIAN ART HISTORY (3)
Howard
Criteria of style and iconography for genuine Buddhist sculpture. Sculpture executed in different media (gilt bronze, stone, wood, and lacquer) and at different times.

16:082:584. CORTONA AND HIS CONTEMPORARIES (3)
Puglisi
Painting in Rome and other key Italian centers from ca. 1620 to 1700, focusing on Pietro da Cortona and the other major artists of his generation who defined Italian High Baroque art.

16:082:595,596. CURATORIAL INTERNSHIP I,II (E3,E3)
Must complete both courses to receive credit. Prerequisites: 16:082:563 and permission of program director.
Internships tailored to the individual's special interest areas.

16:082:597,598. TEACHING APPRENTICESHIP (N1.5,N1.5)

16:082:599. CURATORIAL INTERNSHIP III (E3)
Prerequisites: Completion of 16:082:563 and permission of instructor.
Internship tailored to the individual's special interest areas.

16:082:601,602. SPECIAL TOPICS IN ART HISTORY (3,3)

16:082:612. PROBLEMS IN ANCIENT ART (EARLY GREEK ARCHITECTURAL SCULPTURE) (3)
Kenfield
Seminar on the problems of the origins of the early Greek architectural orders and the kind of sculpture used to decorate those orders.

16:082:615. LYSIPPOS AND THE BEGINNINGS OF HELLENISTIC SCULPTURE (3)
Kenfield
Seminar on the careers of Lysippos and the members of his school and their paramount importance to the development of Hellenistic sculpture.

16:082:620. PROBLEMS IN EARLY CHRISTIAN AND BYZANTINE ART (3)
Harvey
Seminar focusing on a specific medium such as ivory carving, a specific problem such as cultural context, or a specific period such as the Macedonian Renaissance.

16:082:622. PROBLEMS IN MEDIEVAL ART (3)
Seminar with specialized focus on varied topics such as cycles on carved doors, on reliquaries, or in monumental painting.

16:082:624. DONATELLO (3)
McHam
Seminar on Donatello's career: his formation; his influence on his contemporaries such as Masaccio, Desiderio, and altar artists like Verrocchio and Michelangelo.

16:082:630. PROBLEMS IN ITALIAN RENAISSANCE PAINTING (3)
Goffen
Seminar on various topics in Italian painting from 1400 to 1500 such as patronage, gender studies, iconography, work of an individual artist, and cultural context.

16:082:632. PROBLEMS IN EARLY ITALIAN PAINTING (3)
Goffen
Seminar on various topics such as the relation of art and literature; mendicant spirituality; public and private patronage; specialized study of such masters as Giotto, the Lorenzetti, and Paolo da Venezia.

16:082:634. THE HIGH RENAISSANCE (3)
Goffen
Seminar on various topics in Italian art from 1480 to 1600, such as cultural context, patronage, specialized study of one artist's career, the Mannerist crisis, and art theory in painting and sculpture.

16:082:635. PROBLEMS IN LATER RENAISSANCE ART (3)
McHam
Topics in Italian painting, 1500 to 1600, involving patronage, gender studies, iconography, works of an individual artist, and/or cultural context.

16:082:636. TITIAN (3)
Goffen
Titian's career considered in the context of 16th-century society, focusing on his stylistic and thematic innovations in sacred and secular art, notably his depiction of women.

16:082:640. PROBLEMS IN NORTHERN BAROQUE ART (3)
Seminar emphasizing either specific centers of art production or iconographic issues.

16:082:641. PROBLEMS IN BAROQUE ART OF ITALY AND SPAIN (3)
Marder, Puglisi
Seminar on topics related to the leading artists of the period. Matters of style, iconography, religious and political contexts, patronage, and cultural milieu considered.

16:082:643. PROBLEMS IN 18TH-CENTURY ART (3)
Topics related to leading artists of the period, with a primary focus on French art: genre painting and exoticism, the use of drawings, patronage.

16:082:646. SEVENTEENTH-CENTURY PATRONS AND PATRONAGE (3)
Seminar examining the evolving roles of collectors and art dealers, the social context of art collecting, and its impact on artists.

16:082:650. NORTHERN ROMANTICISM (3)
Seminar on specialized topics.

16:082:653. PROBLEMS IN 19TH-CENTURY PAINTING (3)
Bellion, Spector
Seminar on special topics in 19th-century painting: one or more major figures, landscape, art and literature, art criticism.

16:082:654. NINETEENTH-CENTURY FRENCH GRAPHICS (3)
Cate
Seminar based on the Zimmerli Art Museum's 19th-century graphic arts collection.

16:082:655. PROBLEMS IN 20TH-CENTURY ART (3)
Marder
Seminar on special topics in painting and/or sculpture.

16:082:656. PROBLEMS IN AMERICAN ART (3)
Bellion, Yanni
Aspects of American art.

16:082:657. PROBLEMS IN MODERN ART (3)
Spector, Yanni
Seminar on special topics in 20th-century painting: surrealism, t he psychology of art, theories of criticism (psychoanalytic, feminist, semiotic).

16:082:660. PROBLEMS IN MODERN AMERICAN ART (3)
Seminar on specialized topics.

16:082:697,698. EXHIBITION SEMINAR (3,3)
Seminar on research problems and on relevant aspects of the exhibition's ongoing development. An exhibition seminar normally is available at least once a year.

16:082:699. NONTHESIS STUDY (1)

16:082:701,702. RESEARCH IN ART HISTORY (BA,BA)

16:082:705. RESEARCH PROPOSAL IN ART HISTORY (BA)
Prerequisite: Permission of instructor.
Preparation of dissertation proposal. Students must have completed all course work and have scheduled their qualifying examination.

ARTS, VISUAL AND THEATER
(See the catalog of the Mason Gross School of the Arts for information on M.F.A. programs in visual and theater arts.)

ASIAN STUDIES 098

Program Offered: Certificate in Asian Studies
Director of Certificate Program: Professor Ching-I Tu, 330 Scott Hall, College Avenue Campus (732/932-7605)

Participating Faculty

The certificate program in Asian studies is offered as part of a wider, advanced-degree program. The following graduate faculty members, identified more fully under the subject headings, are among those in charge of curricular arrangements for a certificate program in Asian studies:

M. Adas, *History*
Y.M. Cho, *Linguistics*
N.L. Chou, *Communication, Information, and Library Studies*
V. Dayal, *Linguistics*
M. Dutta, *Economics*
I.N. Gang, *Economics*
P. Golden, *History*
A. Howard, *Art History*
M. Matsuda, *History*
M.M. Moffatt, *Anthropology*
D. Roden, *History*
P. Schalow, *Comparative Literature*
L. Schein, *Anthropology*
C.I. Tu, *Comparative Literature*
J.A. Walker, *Comparative Literature*
S.F. Walker, *Comparative Literature*
R.W. Wilson, *Political Science*
C.F. Yü, *Anthropology*

Certificate Program

Students with an interest in any aspect of East, Southeast, or South Asian civilization may under certain conditions pursue a concentration in Asian studies as part of their regular graduate studies. Those who fulfill the requirements may be awarded a Certificate in Asian Studies upon completion of their degree. Some requirements for the certificate may be used to satisfy the student's own graduate degree requirements. These requirements are as follows:

1. Successful completion with a minimum grade-point average of 3.0 in a minimum of two term courses on Asia within the chosen discipline and in a minimum of two term courses on Asia in one or more cognate fields (12 credits in total). At least two of these courses must be at the graduate level;
2. Reading proficiency in an Asian language;
3. Satisfactory completion of a research project in the field of Asian studies;
4. Either a master's thesis or an expanded seminar paper on a topic related to Asia.

Only students already admitted to a degree program in the Graduate School–New Brunswick may participate in the certificate program. Courses in Asian studies are offered by the participating faculty and additional faculty through their departments and graduate degree programs. Further information is available from the director of the certificate program in Asian studies.

BIOCHEMISTRY 115

Degree Programs Offered: Master of Science, Doctor of Philosophy
Acting Director of Graduate Program: Professor Abram Gabriel, Center for Advanced Biotechnology and Medicine, Busch Campus (732/235-5097)

Associate Director of Graduate Program: **Professor N. Ronald Morris,** UMDNJ–RWJMS, Busch Campus (732/235-4081)

Members of the Graduate Faculty

Cory Abate-Shen, *Professor of Neuroscience and Cell Biology,UMDNJ–RWJMS/ CABM; Ph.D., Cornell Medical College*
Molecular processes that control gene expression in vertebrate development and oncogenesis

Stephen Anderson, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Harvard*
Proteases and protease inhibitors; protein folding; molecular recognition; structural bioinformatics

Edward Arnold, *Professor of Chemistry, CABM; Ph.D., Cornell*
Protein and virus structure; AIDS; drug and vaccine design

Jean S. Baum, *Associate Professor of Chemistry, FAS–NB; Ph.D., California (Berkeley)*
Structural studies of proteins by nuclear magnetic resonance techniques

Helen M. Berman, *Professor of Chemistry, FAS–NB; Ph.D., Pittsburgh*
Crystallographic and molecular modeling studies of biological molecules

Leonard Borack, *Associate Professor of Zoology, FAS–N; Ph.D., New York*
Biochemical genetics of **Drosophila**

Kenneth J. Breslauer, *Linus C. Pauling Professor of Chemistry, FAS–NB; Ph.D., Yale*
Drug-DNAinteractions; DNAlesions and mutagenesis/repair; DNAconformational heterogeneity; ligand macromolecular recognition; rational drug design; DNA-based diagnostics and therapeutics

Gary Brewer, *Associate Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; Ph.D., Auburn*
Posttranscriptional control of gene expression in disease

Steven J. Brill, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., SUNY (Stony Brook)*
Eukaryotic DNA replication and genome stability

Barbara Brodsky, *Professor of Biochemistry, UMDNJ–RWJMS; Ph.D., Harvard*
Structure and binding of triple-helix peptides as models for collagen and the macrophage scavenger receptor

George M. Carman, *Professor of Food Science, CC; Ph.D., Massachusetts*
Enzymology of phospholipid metabolism

Kiran K. Chada, *Professor of Biochemistry, UMDNJ–RWJMS; D.Phil., Oxford*
Functional genomics in cancer and obesity

Theodore Chase, Jr., *Professor of Biochemistry, CC; Ph.D., California (Berkeley)*
Enzymology and molecular biology of plants, especially with reference to flavor compounds

Kuang-Yu Chen, *Professor of Chemistry, FAS–NB; Ph.D., Yale*
Biochemistry and function of polyamines and hypasine; gene regulation in cell aging and tumor reversion; nutraceuticals, cancer, and aging

Suzie Chen, *Associate Professor of Chemical Biology and Pharmacognosy, EMSP; Ph.D., Albert Einstein*
Spontaneous melanoma development in transgenic mice; mechanisms of adipocyte differentiation

Xuemei Chen, *Assistant Professor of Genetics, WIM/FAS–NB; Ph.D., Cornell*
Molecular genetic analysis of flower development in **Arabidopsis**

Khew-Voon Chin, *Assistant Professor of Medicine and Pharmacology, CINJ/UMDNJ–RWJMS; Ph.D., Rutgers*
Drug resistance in cancers; regulation of gene expression

David T. Denhardt, *Professor of Cell and Molecular Biology, FAS–NB; Ph.D., California Institute of Technology*
Molecular biology of cancer; cell signaling and regulation of gene expression; structure and function of osteopontin and tissue inhibitor or metalloproteinases

Monica A. Driscoll, *Professor of Molecular Biology and Biochemistry, CABM; Ph.D., Harvard*
Molecular genetics of degenerative cell death; mechanical signaling

Richard H. Ebright, *Professor of Chemistry, WIM/FAS–NB; Ph.D., Harvard*
Transcription; protein-DNAinteraction; protein-protein interaction; single molecule imaging

Isaac Edery, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB/CABM; Ph.D., McGill*
Molecular and cellular mechanisms underlying biological clocks

Julie M. Fagan, *Professor of Animal Sciences, CC; Ph.D., Arizona*
Proteases and their inhibitors in health and disease

Bonnie Firestein, *Assistant Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., California (San Diego)*
Targeting of neuronal proteins

Joseph Fondell, *Assistant Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., SUNY (Stony Brook)*
Regulation of gene expression by nuclear hormone receptors

Abram Gabriel, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB; M.D., Johns Hopkins*
Mechanisms of retrotransposon replication; chromosomal rearrangements

Marc Gartenberg, *Associate Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Yale*
Chromosomal DNAstructure and organization; transcriptional silencing

Donald Gerecke, *Assistant Professor of Pharmacology and Toxicology, EMSP; Ph.D., Harvard*
Molecular biology of lung fibrosis

Marion Gordon, *Associate Professor of Pharmacology and Toxicology, EMSP; Ph.D., UMDNJ/Rutgers*
Collagen gene regulation during cornea development; regulation and function of EMMPRIN, a matrix metalloproteinase stimulator, in normal and transformed cells

Barth Grant, *Assistant Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Princeton*
Endocytosis in **C. elegans**

Samuel Gunderson, *Assistant Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Wisconsin*
Gene expression; pre-mRNAprocessing; autoregulation; splicing; polyadenylation

Sarah E. Hitchcock-DeGregori, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS; Ph.D., Case Western Reserve*
Biochemistry and molecular biology of contractile proteins

Shu-Chan Hsu, *Assistant Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., British Columbia*
Molecular mechanisms of synaptic development and function

Masayori Inouye, *Professor of Biochemistry, UMDNJ–RWJMS; Ph.D., Osaka*
Membrane biogenesis; regulation of synthesis of outer membrane proteins

Sumiko Inouye, *Associate Professor of Biochemistry, UMDNJ–RWJMS; Ph.D., Nagoya*
Myxobacteria and bacterial reverse transcriptases

Kenneth D. Irvine, *Associate Professor of Molecular Biology and Biochemistry, WIM/FAS–NB; Ph.D., Stanford*
Cell signaling and growth control during **Drosophila** *development*

Stephan S. Isied, *Professor of Chemistry, FAS–NB; Ph.D., Stanford*
Modification of electron transfer proteins

Frank Jordan, *Professor of Chemistry, FAS–N; Ph.D., Pennsylvania*
Mechanism of thiamin-dependent enzymes and of serine proteases

Peter C. Kahn, *Associate Professor of Biochemistry, CC; Ph.D., Columbia*
Multisubunit proteins; circular dichroism; agent orange

Frederick C. Kauffman, *Professor of Pharmacology, EMSP; Ph.D., Illinois*
Biochemical aspects of toxicology

Megerditch Kiledjian, *Associate Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Pennsylvania*
RNA-protein interactions in the regulation of eukaryotic gene expression

Terri Goss Kinzy, *Associate Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; Ph.D., Case Western Reserve*
Eukaryotic translation elongation and regulation of gene expression

Tony Ah-Ng Kong, *Professor of Pharmaceutics, EMSP; Ph.D., SUNY (Buffalo)*
Pharmacogenomics and toxicogenomics of cancer chemopreventative compounds

Marilyn Kozak, *Professor of Biochemistry, UMDNJ–RWJMS; Ph.D., Johns Hopkins*
Mechanism of protein synthesis in eukaryotic cells

Eric Lam, *Professor of Plant Science, BCAE/CC; Ph.D., California (Berkeley)*
Plant gene targeting; programmed cell death; chromatin imaging

Jerome Langer, *Associate Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; Ph.D., Yale*
Interferon and receptor structure and function; dengue virus interaction with cells

Debra Laskin, *Professor of Pharmacology and Toxicology, EMSP; Ph.D., Medical College of Virginia*
Immunology; inflammation; cytokines, nitric oxide, macrophages

Jeffrey D. Laskin, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., SUNY (Buffalo)*
Carcinogenesis and differentiation in cell culture; nitric oxide

John Lenard, *Professor of Physiology, UMDNJ–RWJMS; Ph.D., Cornell*
Transcription, replication, and fusion of RNAviruses; cellular fusion mechanisms

Ronald M. Levy, *Professor of Chemistry, FAS–NB; Ph.D., Harvard*
Computational molecular biology; computational chemistry; computer modeling of protein structure; folding and dynamics; structural genomics

Alice Y.-C. Liu, *Professor of Biological Sciences, FAS–NB; Ph.D., Mount Sinai*
Stress, aging, and the role of redox in cell signaling and regulation

Fang Liu, *Assistant Professor of Chemical Biology, EMSP/CABM; Ph.D., Harvard*
Growth and differentiation control

Leroy Liu, *Professor of Pharmacology; UMDNJ–RWJMS; Ph.D., California (Berkeley)*
Cancer biology, cancer pharmacology, DNAconformation dynamics

Kiran Madura, *Associate Professor of Biochemistry, UMDNJ–RWJMS; Ph.D., Rochester*
Mechanism and significance of ubiquitin-dependent degradation of g-alpha

Pal Maliga, *Professor of Genetics, WIM/FAS–NB; Ph.D., Hungarian Academy of Sciences*
Genetics and molecular biology of plastids; RNAediting

Paul Manowitz, *Professor of Psychiatry, UMDNJ–RWJMS; Ph.D., Brandeis*
Molecular biology and biochemistry of mental illness

Tara Matise, *Associate Professor of Genetics, FAS–NB; Ph.D., Pittsburgh*
Computational genetics

Fumio Matsumura, *Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Nagoya*
Molecular cell biology of cell division

Richard Mendelsohn, *Professor of Chemistry, FAS–N; Ph.D., Massachusetts Institute of Technology*
Biophysical studies of membrane structure

Joachim W. Messing, *University Professor of Molecular Biology, WIM/FAS–NB; Ph.D., Munich*
Plant molecular biology

Gaetano T. Montelione, *Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Cornell*
Protein NMR spectroscopy, molecular recognition, rational drug design, structural bioinformatics

N. Ronald Morris, *Professor of Pharmacology, UMDNJ–RWJMS; M.D., Yale*
Molecular biology of microtubules and mitosis

Lenore Neigeborn, *Lecturer in Life Sciences, FAS–NB; Ph.D., Columbia*
Control of gene expression in yeast

Robert A. Niederman, *Professor of Molecular Biology and Biochemistry, FAS–NB; D.V.M., Ph.D., Illinois*
Structure, function, and assembly of photosynthetic membranes

David N. Norris, *Assistant Professor of Molecular Biology and Biochemistry, WIM/FAS–NB; Ph.D., Harvard*
Genetic recombination, meiosis, and check point regulation

Wilma Olson, *Mary I. Bunting Professor of Chemistry, FAS–NB; Ph.D., Stanford*
Relation of structure, conformation, and function in nucleic acids

Richard Padgett, *Professor of Molecular Biology and Biochemistry, WIM/FAS–NB; Ph.D., North Carolina (Chapel Hill)*
TGF-beta signal transduction in **C. elegans** *and* **Drosophila**

Garth Patterson, *Assistant Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Oregon*
Development, signal transduction, genetics, gene expression, aging

Stuart Peltz, *Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; Ph.D., Wisconsin (Madison)*
Eukaryote gene expression

Sidney Pestka, *Professor of Molecular Genetics and Microbiology; M.D., Pennsylvania*
Natural interferons: genes, receptors

George Pieczenik, *Associate Professor of Biochemistry, CC; Ph.D., New York*
Evolutionary paradigms for molecular information

John Pintar, *Professor of Neuroscience, UMDNJ–RWJMS; Ph.D., Oregon*
Molecular analysis of gene expression during mammalian development

Ronald D. Poretz, *Professor of Biochemistry, CC; Ph.D., SUNY (Buffalo)*
Inherited susceptibility to neurotoxicants and intracellular targeting of pharmaceuticals

Carl A. Price, *Professor Emeritus of Plant Biochemistry, WIM/FAS–NB; Ph.D., Harvard*
Molecular biology of plastids

Arnold Rabson, *Professor of Microbiology and Molecular Genetics, UMDNJ–RWJMS; M.D., Brown*
Molecular biology of human retroviruses; gene regulation in human cancer

Joe Ramos, *Assistant Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Virginia*
Cell signaling, cell adhesion, and cancer

Danny F. Reinberg, *Professor of Biochemistry, UMDNJ–RWJMS; Ph.D., Albert Einstein*
Mechanisms that control the regulation of gene expression in higher eukaryotes

Charles Roth, *Assistant Professor of Chemical and Biochemical Engineering, SE; Ph.D., Delaware*
Molecular bioengineering, inflammatory diseases, applied bioinformatics

Monica Roth, *Professor of Biochemistry, UMDNJ–RWJMS; Ph.D., Albert Einstein*
Genetics and biochemistry of murine leukemia virus

Carl P. Schaffner, *Professor Emeritus of Biology, WIM/FAS–NB; Ph.D., Illinois*
Antibiotic chemistry and biology; prostatic cholesterogenesis

Konstantin Severinov, *Associate Professor of Genetics, FAS–NB; Ph.D., Russian Academy of Sciences*
Structure and function of RNApolymerases from eubacteria and yeasts

Aaron Shatkin, *Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; University Professor of Molecular Biology, Rutgers; Director of the Center for Advanced Biotechnology and Medicine; Ph.D., Rockefeller*
Eukaryotic gene expression; viral cytopathogenesis

Michael M. Shen, *Associate Professor of Pediatrics, UMDNJ–RWJMS/CABM; Ph.D., Cambridge*
Growth factor signaling and pattern formation in mouse embryogenesis; prostate development and cancer

Steven Shiff, *Associate Professor of Medicine, UMDNJ–RWJMS; Ph.D., Pennsylvania*
Role of diet and nutrition in prevention of chronic disease

Navin K. Sinha, *Associate Professor of Biology, WIM/FAS–NB; Ph.D., Minnesota*
Accuracy of DNA replication; chemical carcinogenesis

William Sofer, *Professor of Genetics, FAS–NB; Ph.D., Miami*
Prediction of secondary structure of proteins using genetic algorithms

Ruth Steward, *Professor of Molecular Biology and Biochemistry, WIM/FAS–NB; Ph.D., Basel*
Nuclear migration, RNAlocalization, and patterning in **Drosophila**

Ann Stock, *Associate Professor of Biochemistry, UMDNJ–RWJMS/CABM; Ph.D., California (Berkeley)*
Structure and function of signal transduction proteins

Kevin S. Sweder, *Assistant Professor of Chemical Biology, EMSP; Ph.D., California Institute of Technology*
Mechanisms of DNA repair; transcription-coupled repair; translesion synthesis

Mark Takahashi, *Associate Professor of Physiology, UMDNJ–RWJMS; Ph.D., Wisconsin*
Cytokine signal transduction pathways; apoptosis in epithelial cells

T.J. Thomas, *Associate Professor of Medicine, UMDNJ–RWJMS; Ph.D., Indian Institute of Science*
Development of gene-targeted strategies for breast cancer treatment

Chih-Cheng Tsai, *Assistant Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., SUNY (Stony Brook)*
Transcriptional regulation, nuclear receptor corepressors, **Drosophila** *development*

Lynn D. Vales, *Associate Professor of Biochemistry, UMDNJ–RWJMS; Ph.D., Albert Einstein College of Medicine*
Transcriptional regulation of gene expression

Theodorus van Es, *Professor of Biochemistry, CC; Ph.D., Witwatersrand*
Carbohydrate chemistry; nonimmunogenic enzymes; quinoline chemistry

Andrew K. Vershon, *Professor of Molecular Biology and Biochemistry, WIM/FAS–NB; Ph.D., Massachusetts Institute of Technology*
Structure/function of yeast transcriptional regulatory proteins

Nancy Walworth, *Associate Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Yale*
Regulation of cell cycle progression in eukaryotic cells

William W. Ward, *Professor of Biochemistry, CC; Ph.D., Johns Hopkins*
Bioluminescence mechanisms; protein and peptide biochemistry

Eileen White, *Professor of Molecular Biology and Biochemistry, FAS–NB/CABM; Ph.D., SUNY (Stony Brook)*
Programmed cell death

Lori White, *Assistant Professor of Biochemistry, CC; Ph.D., Dartmouth*
Molecular mechanisms of xenobiotic-induced pathologies

Donald Winkelmann, *Associate Professor of Pathology, UMDNJ–RWJMS; Ph.D., Wisconsin (Madison)*
Macromolecular structure and assembly mechanisms of muscular contraction

Chung S. Yang, *Professor of Chemical Biology, EMSP; Ph.D., Cornell*
Molecular mechanisms of esophageal carcinogenesis and its prevention; genetic polymorphism and cancer risk

Guofeng You, *Associate Professor of Pharmaceutics, EMSP; Ph.D., Clark*
Molecular and cellular pharmacology, drug/toxin elimination

Peter D. Yurchenco, *Professor of Pathology and Laboratory Medicine, UMDNJ–RWJMS; M.D., Ph.D., Albert Einstein College of Medicine*
Molecular basis of basement membrane structure and function; receptor-mediated cell-matrix interactions

Barbara A. Zilinskas, *Professor of Plant Biochemistry, CC; Ph.D., Illinois*
Oxidative stress in plants and microorganisms; plant molecular biology and biochemistry

Gerben Zylstra, *Associate Professor of Biochemistry and Microbiology, BCAE/CC; Ph.D., Michigan*
Microbial genomics; high throughput screening; molecular analysis of biodegra - tion pathways

Programs

The joint graduate program in biochemistry at Rutgers, The State University of New Jersey, and the University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School provides high-quality graduate training in biochemistry. There are two appropriate undergraduate routes that prepare a student well for graduate study in biochemistry. The most obvious is an under-graduate concentration in biochemistry itself. Alternatively, a stu-dent could major in either biology—particularly molecular biology, cell biology, or microbiology—or chemistry—particularly organic chemistry or physical chemistry. Whichever major the student declares in this second route should be accompanied by a minor in the other discipline. Applicants also are expected to have studied mathematics through calculus, and to have completed one year of physics, and analytical and physical chemistry. Those who lack one or two of these prerequisites may complete them without graduate credit after admission to graduate school. Applicants also are required to take the general and subject tests of the Graduate Record Examination. *

* Admission is handled by the consolidated graduate programs in molecular biosciences. For further information, refer to the Molecular Biosciences heading within this chapter.

This program involves several departments and more than one institution. It covers a variety of research areas in biochemistry and molecular biology that include regulation of DNA replication and transcription, virus gene expression, gene expression in development and differentiation, tumor biology, molecular genetics, structural biochemistry, plant molecular biology, signal transduction and molecular targeting, cell cycle control, membrane biochemistry, protein chemistry, muscle biochemistry, and enzymology. Faculty members are drawn from the departments of molecular biology and biochemistry, chemistry, cell biology and neuroscience, and applied microbiology and plant physiology, the Waksman Institute of Microbiology, and the Biotechnology Center for Agriculture and the Environment at Rutgers. Other faculty members come from the departments of biochemistry, neuroscience and cell biology, pathology, physiology, pharmacology, and microbiology and molecular genetics at UMDNJ. Additional faculty members are drawn from the Center for Advanced Biotechnology and Medicine, a joint center operated by Rutgers and UMDNJ.

The Ph.D. program has been updated to address the recent remarkable developments in molecular biology and biochemistry. It requires a minimum of 30 credits of course work and 42 credits of advanced research. Ph.D. students take a common first-year core curriculum as described under the molecular biosciences heading within this chapter. The course requirements for the Ph.D. include 16:115:501 Biochemistry (3 credits); 16:115:502 Biochemistry (Molecular Biology) (3 credits); 16:115:613,614 Seminar in Biochemistry (2 credits); 16:160:537 Biophysical Chemistry I (3 credits), or its equivalent; 16:695:601 Advanced Cell Biology (3 credits); 16:695:615,616 Laboratory Rotation in Molecular and Cell Biology I,II (6 credits); and electives (6 credits). The above requirements may be coordinated with the requirements of the first-year core curriculum for the consolidated programs in molecular biosciences. The Ph.D. program also requires a minimum of one year of full-time research in residence.

Joint Ph.D. degrees are available in this program. See the Degree Programs Available chapter.

Graduate Courses

16:115:501. (F) BIOCHEMISTRY (3)
Winkelmann. Prerequisite: One year organic chemistry. Corequisite: 16:115:502.
Modern concepts of protein biochemistry and metabolism for first-year Ph.D. students.

16:115:502. (F) BIOCHEMISTRY (MOLECULAR BIOLOGY) (3)
Inouye. Prerequisite: One year organic chemistry. Corequisite: 16:115:501.
Modern concepts of nucleic acid biochemistry and metabolism for first-year Ph.D. students.

16:115:508. (S) PROTEINS AND ENZYMES (3)
Chase. Prerequisite: 16:115:501 or equivalent.
Assay and purification of enzymes and other proteins. Kinetics, chemical modification, and site-directed mutagenesis as tools in understanding structure-function relationships and enzyme mechanisms. Selected examples of posttranslational modification. General theories and specific examples of the chemical basis of enzymic catalysis.

16:115:511,512. (F) MOLECULAR BIOLOGY AND BIOCHEMISTRY (3,3)
Prerequisite: One year organic chemistry. These courses recommended for students outside the program in biochemistry.
First term: structure and function of proteins, nucleic acid structure, catalysis of biochemical reactions, glycolysis, oxidative phosphorylation. Recombinant DNA approaches, DNA replication, mutability, recombination, repair, and transposition. *Second term:* transcription, posttranscriptional processing, translation, gene regulation, photosynthesis, properties of membranes, signal transduction, intermediary metabolism.

16:115:533. (F) PHYSICAL BIOCHEMISTRY (3)
Kahn. Prerequisites: Biochemistry, physical chemistry.
Protein folding used as theme to discuss principles of physical chemistry of macromolecules of biochemical importance. Specific aspects of thermodynamics and kinetics are related to biopolymers. Spectroscopic techniques, including circular dichroism, as well as other biophysical methods.

16:115:552. BIOCHEMICAL SEPARATIONS (3)
Prerequisite: 01:115:313 or 11:115:313; or 11:115:413.
Basic theory and practice of separating biological molecules. Methods include chromatography, centrifugation, electrophoresis, ultrafiltration, and general methods of extraction and purification of proteins, nucleic acids, carbohydrates, and other biological molecules.

16:115:554. (F) GENE REGULATION IN NEURAL DEVELOPMENT (2)
Abate-Shen. Offered in alternate years.
Survey of recent literature regarding the regulation of gene expression in the nervous system. Emphasis on the molecular mechanisms involved in gene regulation during neuronal development.

16:115:556. (F) ETHICAL SCIENTIFIC CONDUCT (1)
Introduction to ethical issues of scientific investigation, including intellectual property, plagiarism, conflict of interest, human and animal subjects, and record keeping. Intended for Ph.D. candidates in the biomedical sciences.

16:115:605,606. ADVANCED STUDIES IN BIOCHEMISTRY (BA,BA)
Independent library and laboratory research into special aspects of biochemistry arranged under the supervision of faculty members in any of the participating groups.

16:115:613,614. SEMINAR IN BIOCHEMISTRY (1,1)

16:115:616. SPECIAL TOPICS IN BIOCHEMISTRY (BA)
Faculty members occasionally offer a special course on a new or developing topic in biochemistry.

16:115:701,702. RESEARCH IN BIOCHEMISTRY (BA,BA)

BIOMAPS 118
(Program in Quantitative Biology)

Degree Program Offered: **Doctor of Philosophy**
Director of Graduate Program: **Professor Andrei E. Ruckenstein, Physics and Astronomy Building, Busch Campus (732/445-4329)**

Members of the Graduate Faculty

Michael Andrec, *Assistant Research Professor of Chemistry and Chemical Biology, FAS–NB; Ph.D., Yale*
Computational chemistry of protein structure and dynamics
Edward Arnold, *Professor of Chemistry and Chemical Biology, FAS–NB; Ph.D., Cornell*
Crystallographic studies of human viruses and viral proteins
David E. Axelrod, *Professor of Genetics, FAS–NB; Ph.D., Tennessee*
Cellular and molecular oncology; tumor-cell proliferation
Jean S. Baum, *Professor of Chemistry and Chemical Biology, FAS–NB; Ph.D., California (Berkeley)*
Structural studies of proteins by nuclear magnetic resonance techniques
Helen Berman, *Board of Governors Professor of Chemistry and Chemical Biology, FAS–NB; Ph.D., Pittsburgh*
X-ray crystallographic and molecular modeling studies of biological molecules
Ira Black, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS; M.D., Harvard*
Environmental regulation of neuronal gene expression and information flow in the nervous system; brain growth and trophic factors; stem cell biology
Kenneth J. Breslauer, *Professor of Chemistry and Chemical Biology, FAS–NB; Ph.D., Yale*
Biopolymer structures and drug-nucleic acid interactions
Bernard D. Coleman, *Professor of Thermomechanics, SE; Ph.D., Yale*
Continuum mechanics, analysis
Monica Driscoll, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Harvard*
C. elegans *developmental genetics; molecular mechanisms of inherited neurodegeneration*

Stanley M. Dunn, *Professor of Bioengineering, SE; Ph.D., Maryland; Ph.D., Free University of Amsterdam*
Quantitative radiography; bone densitometry; image analysis microscopy

Richard Ebright, *Professor of Chemistry, FAS–NB/WIM; Ph.D., Harvard*
Protein-DNAinteraction; protein engineering; regulation of gene expression

Martin Farach-Colton, *Associate Professor of Computer Science, FAS–NB; M.D., Johns Hopkins; Ph.D., Maryland*
Computational biology; design and analysis of algorithms

Marc R. Gartenberg, *Associate Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Yale*
Nuclear organization of DNA; chromosome structure; yeast plasmid segregation

Israel Gelfand, *Distinguished Visiting Professor of Mathematics, FAS–NB; Ph.D., Moscow State*
Mathematics; artificial intelligence; neuroanatomy; cell biology

Jody Hey, *Professor of Genetics, FAS–NB; Ph.D., SUNY (Stony Brook)*
Evolution, speciation, human origins, recombination, natural selection, codon bias

Tomasz Imielinski, *Professor of Information and Computer Science, FAS–NB; Ph.D., Polish Academy of Sciences*
Mobile wireless computing; data mining

Lev Ioffe, *Professor of Physics, FAS–NB; Ph.D., Landau Institute for Theoretical Physics*
Condensed-matter theory

Kenneth D. Irvine, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB/WIM; Ph.D., Stanford*
*Cell signaling and growth control during **Drosophila** development*

Rebecka Jornsten, *Assistant Professor of Statistics, FAS–NB; Ph.D., California (Berkeley)*
Interface of information theory and statistics; analysis of gene expression data

Casimir Kulikowski, *Professor of Computer Science, FAS–NB; Ph.D., Hawaii*
Artificial intelligence; pattern recognition; imaging; biomedical applications

Joel Lebowitz, *George William Hill Professor of Mathematics and Director of the Center for Mathematical Sciences Research/Professor of Physics, FAS–NB; Ph.D., Syracuse*
Mathematical physics; statistical mechanics

Katherine Lee, *Assistant Professor of Chemistry and Chemical Biology, FAS–NB; Ph.D., Harvard*
Biological and organic reactivity, recognition, and catalysis; computational chemistry; mass spectrometry

Ronald Levy, *Board of Governors Professor of Chemistry and Chemical Biology, FAS–NB; Ph.D., Harvard*
Biophysical chemistry, structure and dynamics of macromolecules; chemical physics

Gerald S. Manning, *Professor of Chemistry and Chemical Biology, FAS–NB; Ph.D., California (San Diego)*
Theory of polyelectrolytes; ionic effects on biopolymers

Aram Mekjian, *Professor of Physics, FAS–NB; Ph.D., Maryland*
Theoretical nuclear physics

Joachim Messing, *Professor of Genetics, Waksman Institute, FAS–NB/WIM; Ph.D., Munich*
Molecular biology of higher plants; M13 cloning, sequencing, gene synthesis

Dimitri Metaxas, *Professor of Computer Science, FAS–NB; Ph.D., Toronto*
Physics-based modeling; computer graphics and animation; computational vision; medical imaging

Prabhas Moghe, *Associate Professor of Chemical and Biochemical Engineering, SE; Ph.D., Minnesota*
Bioengineering and microarchitecture of polymeric tissue analogs; cell-biomaterial interactions; tissue engineering of liver, skin, and blood vessels; fluid flow and "cellular stress engineering"; quantitative 3-D reconstructive confocal microscopy

Gaetano Montelione, *Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Cornell*
Protein NMR spectroscopy, molecular recognition, rational drug design, structural bioinformatics

Wilma Olson, *Mary I. Bunting Professor of Chemistry and Chemical Biology, FAS–NB; Ph.D., Stanford*
Theoretical studies of nucleic acid structure and properties

Richard W. Padgett, *Professor of Molecular Biology and Biochemistry, FAS–NB/WIM; Ph.D., North Carolina (Chapel Hill)*
*Molecular genetics of development in **Drosophila** and **C. elegans***

Vladimir Pavlovic, *Assistant Professor of Computer Science, FAS–NB; Ph.D., Illinois (Urbana-Champaign)*
Applied machine learning and probabilistic inference, bioinformatics, computer vision, and human-computer interaction

Danny Reinberg, *Distinguished Professor of Biochemistry, UMDNJ–RWJMS; Ph.D., Einstein*
Regulation of gene expression

Fred Roberts, *Professor of Mathematics, Director, DIMACS, FAS–NB; Ph.D., Stanford*
Discrete mathematical models; graph theory; decision making; measurement theory

Charles Roth, *Assistant Professor of Chemical and Biochemical Engineering, SE; Ph.D., Delaware*
Molecular bioengineering; gene-based technologies; cell systems engineering

Andrei Ruckenstein, *Professor of Physics, FAS–NB; Ph.D., Cornell*
Complex biological systems; transcription regulation; gene repair; biological regulatory networks; computational developmental biology

Anirvan Sengupta, *Associate Professor of Physics, FAS–NB; Ph.D., Tata Institute, Bombay*
Information processing systems in cell biology; signal transduction networks and transcriptional circuits; statistical physics; signal processing and network analysis

Konstantin Severinov, *Associate Professor of Genetics, FAS–NB/WIM; Ph.D., Russian Academy of Sciences*
Structure and function of RNApolymerases from eubacteria and yeasts

Lawrence Shepp, *Professor of Statistics, FAS–NB; Ph.D., Princeton*
Pure and applied probability tomography

Boris Shraiman, *Professor of Physics, FAS–NB; Ph.D., Harvard*
Complex systems; transcription regulation; regulation of enzymatic signal transduction pathways; fluctuations; spatial localization; kinetic models

William H. Sofer, *Professor of Molecular Biology and Biochemistry, FAS–NB/WIM; Ph.D., Miami*
Genetic algorithms for predicting secondary structure of proteins

Eduardo Sontag, *Professor of Mathematics, FAS–NB; Ph.D., Florida*
System and control theory

Ruth Steward, *Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Basel*
*Nuclear migration, RNAlocalization and patterning in **Drosophila***

Ann M. Stock, *Professor of Biochemistry, UMDNJ–RWJMS/CABM; Ph.D., California (Berkeley)*
Structure and function of signal transduction proteins

David Talaga, *Assistant Professor of Chemistry and Chemical Biology, FAS–NB; Ph.D., California (Los Angeles)*
Single molecule studies of inorganic and biological polymers; vibrational spectroscopy

Jay Tischfield, *Professor of Genetics, FAS–NB; Ph.D., Yale*
Gene regulation, human genetics diseases

Andrew Vershon, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB/WIM; Ph.D., Massachusetts Institute of Technology*
Regulation of gene expression in yeast

John Westbrook, *Associate Research Professor of Chemistry and Chemical Biology, FAS–NB; Ph.D., Rutgers*
Databases for protein and nucleic acid structures

Martin Yarmush, *Visiting Professor of Biomedical Engineering, SE; Ph.D., Rockefeller; M.D. Yale*
Tissue engineering, metabolic engineering, genomics and proteomics, stem cell bioengineering

Norman Zabusky, *Professor of Mechanical and Aerospace Engineering, SE; Ph.D., California Institute of Technology*
Fluid dynamics; computational and analytical; nonlinear dynamical systems

Program

During the half-century since the elucidation of the structure of DNA, there has been a remarkable increase in the rate of biological discovery. Making sense of the ever-increasing amount and scope of biological information—at levels of complexity ranging from molecules, through assemblies of molecules, to cells—requires sophisticated mathematical and computational tools outside the realm of mainstream biology. The BIOMAPS program seeks to train a new generation of scientists who will be able to use these tools to achieve a new level of understanding of biology. The graduate program will be administered under the umbrella of the BIOMAPS Institute for Quantitative Biology, the goal of which is to foster interdisciplinary research and education at the interface between Biology and the Mathematical and Physical Sciences (BIOMAPS).

The BIOMAPS graduate program's curriculum, course prerequisites, and admission requirements have been designed to serve the needs of students with diverse backgrounds, particularly those with quantitative training in the physical, mathematical, and computer sciences. The BIOMAPS program allows the enrollment of interdisciplinary students who do not fit naturally into any traditional graduate program but who show a strong interest and/or aptitude for interdisciplinary biology research. These students enroll directly into BIOMAPS and must satisfy BIOMAPS requirements. Another option for interdisciplinary study currently under development will be the special, parallel "bio-tracks" in traditional programs that will prepare students for biology-driven research. The parallel tracks will strengthen connections with traditional disciplines whose intellectual traditions and technical body of knowledge have many times been the driving force for technical

developments and novel experimental tools in interdisciplinary research. Parallel tracks will substitute a number of credits (yet to be determined) of the Ph.D. program requirements with biology and BIOMAPS courses and, as a rule, students will work on a thesis under the supervision of one of the BIOMAPS faculty with expertise in the traditional discipline.

The BIOMAPS graduate curriculum involves three types of courses: background courses, core courses, and electives.

Background Courses. These provide basic introductions to (1) chemistry and biochemistry (3 credits); (2) molecular biology, cell biology, and genetics (3 credits); and (3) laboratory methods of modern biology research (2 credits). The basic courses (1) and (2) are meant for mathematical and physical science and engineering students with insufficient chemistry or biology backgrounds to enroll into graduate courses offered by the molecular biosciences program. They assume no prior training in chemistry and biology, and will provide the chemical and biological foundations needed to understand biological systems. The laboratory methods course will provide a hands-on approach to modern biology techniques and is required of students planning to focus on theoretical research.

Core Courses. These are specifically designed interdisciplinary courses that survey particular BIOMAPS areas and are meant to transition students into research at the forefront of the field. These courses cover a broad range of topics, i.e., protein structure; biophysics of molecular assemblies; algorithms in bioinformatics; simulation techniques; biochemical and genetic networks; signaling, data mining, and pattern recognition; mathematical modeling and control theory.

Electives. Courses are taught by BIOMAPS teaching faculty within traditional doctoral programs that expose students to the techniques and scientific standards of traditional disciplines, many of which form the basis of technical and computational developments in BIOMAPS research. Students can select electives with the approval of their advisory committee from virtually all graduate courses offered by life-science, mathematical and physical sciences, computer science, and engineering programs at Rutgers and UMDNJ including biochemistry, biomedical engineering, cell and developmental biology, chemical and biochemical engineering, chemistry and chemical biology, computer science, mathematics, mechanical and aerospace engineering, mechanics, microbiology and molecular genetics, cellular and molecular pharmacology, physics and astronomy, and statistics.

Requirements for the Ph.D. Degree

Course Requirements. During their first year, BIOMAPS graduate students must take the three one-term background courses as well as two core courses of their choice. Students with adequate preparation may test out of one or more background courses and replace them with an equivalent number of core or elective courses. During their graduate career, BIOMAPS students must enroll in at least 12 credits of BIOMAPS courses (not including background courses or replacements for background courses); at least 6 credits should be earned from the list of special BIOMAPS core courses, and 3 credits from biology courses/seminars offered by the consolidated graduate programs in molecular biosciences. The remaining credits can be earned in courses selected from any of the remaining BIOMAPS core courses; BIOMAPS elective courses offered by BIOMAPS participating departments including those offered under the molecular biosciences umbrella; or seminar courses in computational molecular biology and structural bioinformatics as well as the seminar course sponsored by the Center for Molecular Biophysics and Biophysical Chemistry. In addition, students will be required to enroll in the joint Rutgers and UMDNJ–RWJMS course: 16:115:556 Ethical Scientific Conduct (1 credit).

Research Rotations. BIOMAPS graduate students will be required to complete three research rotations (1 credit each) during the first academic year and/or the summer term following their first year. Research rotations will consist of two-month research projects in research laboratories/groups selected by students, and will allow students to sample prospective dissertation projects in different research environments.

Teaching Requirement. During the second year, students will serve as teaching assistants for two one-term courses, leading discussion sections associated with a lecture course for at least one of the two terms. Teaching is included in the program as part of our emphasis on training students to express themselves clearly and communicate the results of their research effectively. Teaching effectiveness will be evaluated by a faculty member who is a teaching mentor as well as by the customary "teacher evaluation" forms.

Examinations. Each student will be required to pass two major oral qualifying examinations (exam A, exam B). During the second year, each student will be required to demonstrate an aptitude for independent research by presenting a literature review or research talk before their faculty committee (exam A). At the beginning of the third year, each student will be required to submit and defend a proposal for dissertation research (exam B). In addition to exams A and B, the student's progress will be monitored through annual oral progress reports in front of the student's Ph.D. committee. Finally, to complete the Ph.D. degree each student will be required to submit and defend a dissertation.

Graduate Courses

Background Courses

16:118:501. FUNDAMENTALS OF CHEMISTRY AND BIOCHEMISTRY (3)
Prerequisites: Undergraduate science degree and permission of instructor.
Introduction to chemistry and biochemistry for students who have a mathematical, physical, or computer science background.

16:118:502. FUNDAMENTALS OF MOLECULAR BIOLOGY, CELL BIOLOGY, AND GENETICS (3)
Prerequisites: Undergraduate science degree and permission of instructor.
Introduction to three major fields of biology for students who have a mathematical, physical, or computer science background.

16:118:504. LABORATORY METHODS OF MODERN BIOLOGY RESEARCH (2)
Prerequisites: Undergraduate science degree and permission of instructor.
Introduction to basic laboratory methods, record keeping, and safety, followed by supervised participation in modern laboratory techniques including DNApreparation, ligation, PCR amplification, sequencing, and agarose gel electrophoresis.

Core Courses

16:118:405. DIFFERENTIAL EQUATIONS IN BIOLOGY (3)
Sontag. Prerequisites: Differential equations and linear algebra.
Models for biological processes based on deterministic ordinary and partial differential equations. Topics include stability, bifurcations, periodic phenomena, transport, and diffusion.

16:118:503. INTRODUCTION TO BIOMAPS: BIOLOGY AT THE INTERFACE WITH THE MATHEMATICALAND PHYSICAL SCIENCES (3)
Ruckenstein. Prerequisites: Linear algebra; calculus; and a good biology, chemistry, and physics background at the high school level.
Introduction to the phenomena ranging from molecular interactions to biological behavior at the level of cells, tissues, and organisms.

16:118:505. MATHEMATICAL FOUNDATIONS FOR BIOLOGY (3)
Prerequisites: Calculus, some undergraduate exposure to ODEs, linear algebra, and basic probability.
This is a remedial course focusing on differential equations, Fourier and Laplace transforms, and stochastic processes for students interested in quantitative biology.

16:118:507. PHYSICS OF LIVING MATTER (3)
Shraiman. Prerequisites: Linear algebra, differential equations, thermodynamics, and classical physics (at the junior level).
Review of physical phenomena that determine the properties of biological molecules, molecular assemblies, and fundamental biological processes.

16:118:509. BIOPHYSICAL CHEMISTRY (3)
Baum, Berman, Ebright. Prerequisite: Permission of instructor.
Principles of biomacromolecular structure and dynamics including methods for representing and visualizing these molecules; biophysical methods; and methods for studying enzyme kinetics and protein-ligand binding. Introduction to various bioinformatics resources.

16:118:511. MODELING OF BIOMOLECULAR NETWORKS: AN INTRODUCTION TO SYSTEMS BIOLOGY (3)
Sengupta. Prerequisites: Differential equations, linear algebra, probability and statistics; good chemistry/biology background at the high school level.
Focuses on a systems approach to biomolecular processes including the ideas, mathematical language, and modeling techniques used to describe the main mechanisms of transferring and processing of biological information.

16:118:513. MOLECULAR SIMULATIONS IN COMPUTATIONAL BIOLOGY (3)
Levy, Olson. Prerequisites: Advanced undergraduate courses in physical chemistry or physics.
Focuses on molecular modeling and simulations of biological macromolecules including proteins and nucleic acids, molecular dynamics and Monte Carlo methods, and solvation. Computer simulations and exercises are an integral part of the course.

16:118:515. STATISTICAL METHODS IN BIOINFORMATICS (3)
Jornsten. Prerequisites: Linear algebra and calculus.
Broadly applicable, modern statistical tools particularly important in modeling and interpreting noisy bioinformatics data.

16:118:520. ALGORITHMIC BIOINFORMATICS: A COMPUTER SCIENCE PERSPECTIVE (3)
Farach-Colton. Prerequisite: Basic analysis of algorithms course.
Advanced introduction to computational molecular biology covering sequence comparison, phylogeny, gene finding, comparative genomics and genome rearrangements, and haplotype inference; focuses on analyzing the complexity and efficiency of computational methods.

16:118:601. PROTEIN PHYSICS (3)
Levy. Prerequisite: Permission of instructor.
Advanced introduction to protein folding, binding, and structure prediction including equilibrium and kinetic aspects of protein folding and binding, classification of protein folds, and structure prediction from sequence.

16:118:602. PROBABILISTIC GRAPHICAL MODELS (3)
Pavlovic. Prerequisites: Knowledge of probability and random processes.
Advanced introduction to probabilistic graphical models, from Bayesian networks to factor graphs. Modeling techniques and advanced inference and learning algorithms, methods particularly relevant to current bioinformatics research.

16:118:603. REGULATION OF GENE TRANSCRIPTION (3)
Prerequisite: Permission of instructor.
Broad review of the regulation of gene transcription combining biophysics, structural biology, systems biology, bioinformatics, and control theory points of view.

16:118:605. PATTERN FORMATION IN BIOLOGY: SIGNAL TRANSDUCTION, BIOMOLECULAR, AND GENETIC NETWORKS IN DEVELOPMENT (3)
Prerequisite: Permission of instructor.
Combines a molecular genetics description with quantitative modeling and physical view of pattern formation. Topics include robustness in genetic networks, limb regeneration, cell survival and death in development.

16:118:611. COMPLEX SYSTEMS: PHYSICAL REALITY AND MATHEMATICAL MODELS (3)
Lebowitz. Prerequisites: Familiarity with statistical mechanics and/or probability theory and dynamical systems theory.
Deterministic equations and probabilistic ideas from statistical mechanics will be used to describe organized behavior emerging from many interacting simple entities. Complex systems include the brain and chemical phase transitions.

16:118:613. SELECTED MATH TOPICS IN PHYSIOLOGY AND MEDICINE (3)
Sontag. Prerequisite: Elementary differential equations or permission of instructor.
Mathematical modeling of selected biological phenomena and systems. Cellular homeostasis, regulation of cell function, cardiac rhythmicity, and hormone physiology are potential topics.

16:118:616. SPECIAL TOPICS IN QUANTITATIVE BIOLOGY (3)
Prerequisite: Permission of instructor.

16:118:621,622. LABORATORY ROTATION IN BIOMAPS INSTITUTE LABORATORIES (1-2 BA,1-2 BA)
Enrollment restricted to Ph.D. students in the BIOMAPS graduate program. No more than a total of 3 credits of laboratory rotation can be earned.
Introduction to the techniques of BIOMAPS research through participation in research projects of selected members of the graduate faculty.

16:118:701,702. BIOMAPS INSTITUTE RESEARCH (BA,BA)

BIOMEDICAL ENGINEERING 125

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Thomas Papathomas, 113 Biomedical Engineering Building, Busch Campus (732/445-3706 or 732/445-4462)**
Codirector of Graduate Program: **Professor Michael G. Dunn, Medical Education Building, Room 424, UMDNJ–RWJMS (732/235-7972)**

Members of the Graduate Faculty

Harold Alexander, *President, Orthogen, Inc., New York; President, Academic Research and Analysis, Short Hills, New Jersey*
Biomechanics; biomaterials; orthopedic implant design
Helen M. Buettner, *Associate Professor of Chemical and Biomedical Engineering, SE; Ph.D., Pennsylvania*
Chemical and biochemical engineering; nerve regeneration
Grigore C. Burdea, *Associate Professor of Electrical and Computer Engineering, SE; Director, Human-Machine Interface Laboratory; Ph.D., New York*
Medical robotics and virtual reality; biomechanics; rehabilitation
Bernard Coleman, *Professor of Mathematics, SE; Ph.D., Yale*
Mathematical sciences; molecular, cellular, and nanosystems bioengineering
Richard J. Contrada, *Associate Professor of Psychology; Ph.D., New York*
Cardiovascular psychophysiology personality, identity, and self-regulation; prevention of and adaptation to chronic disease
William Craelius, *Associate Professor of Biomedical Engineering, SE; Ph.D., Northwestern*
Cardiac and neural electrophysiology
Stephen Danforth, *Professor of Ceramic and Materials Engineering, SE; Ph.D., Brown*
Membrane biophysics; cellular mechano-electric systems; prosthetics; rehabilitation engineering
Gary M. Drzewiecki, *Professor of Biomedical Engineering, SE; Ph.D., Pennsylvania*
Circulatory system dynamics; noninvasive hemodynamics; chaos and fractals
Michael G. Dunn, *Associate Professor of Surgery, UMDNJ–RWJMS; Ph.D., Rutgers*
Tissue engineering for tendons/ligaments, resorbable biomaterials, wound healing, biomaterials
Stanley M. Dunn, *Professor of Biomedical Engineering, SE; Ph.D., Maryland; Ph.D., Free University of Amsterdam*
Quantitative radiography; bone densitometry; image analysis microscopy
Sandra J. England, *Professor of Pediatrics, UMDNJ–RWJMS; Ph.D., Dartmouth*
Neonatal development of respiratory control system
Charles Gatt, *Clinical Assistant Professor of Surgery, UMDNJ–RWJMS*
Herbert M. Geller, *Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Case Western Reserve*
Cellular mechanisms of neurotransmission
Abdullah N. Guzelsu, *Associate Professor of Biomechanics, UMDNJ–SOM; Ph.D., Princeton*
Biomechanics; bone; electromechanical properties of tissues
Joseph Kedem, *Associate Professor of Physiology, UMDNJ–RWJMS; Ph.D., Hebrew (Israel)*
Quantitative relation between cardiac function and metabolism
Joachim B. Kohn, *Professor of Chemistry, FAS–NB; Ph.D., Weizmann Institute of Science*
Interaction of living cells with artificial surfaces

John B. Kostis, *Professor and Chairperson of Medicine, UMDNJ–RWJMS, and Adjunct Professor of Biomedical Engineering, SE; M.D., Athens*
Cardiovascular diseases and hypertension

Eileen Kowler, *Professor of Psychology, FAS–NB; Ph.D., Maryland*
Eye movements and visual information processing

Noshir A. Langrana, *Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Cornell*
Spinal mechanics; fracture fixation; knee joint; kinematics

Richard Lehman, *Professor of Neurosurgery, UMDNJ–RWJMS; M.D., Temple*
Parkinson's disease and seizure disorders

John K.-J. Li, *Professor of Biomedical Engineering, SE; Ph.D., Pennsylvania*
Cardiovascular dynamics; biomedical instrumentation

Jianjie Ma, *Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., Baylor College of Medicine*
Molecular, cellular, and nanosystems bioengineering

Adrian Mann, *Assistant Professor of Ceramic and Materials Engineering, SE; Ph.D., Oxford*
Nanotechnology; biomaterials and tissue engineering

Dinos Mavroidis, *Assistant Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Paris*
Design and controls

Dimitris Metaxas, *Professor of Biomedical Engineering and Computer Science, SE; Ph.D., Toronto*
Computational bioengineering; biomedical imaging

Evangelia Micheli-Tzanakou, *Professor and Chairperson of Biomedical Engineering, SE; Ph.D., Syracuse*
Visual pattern recognition; neural networks; digital signal processing

Prabhas V. Moghe, *Assistant Professor of Chemical and Biochemical Engineering, SE; Ph.D., Minnesota*
Matrix microarchitecture, tissue engineering, cell-biomaterials interactions

Gary Nackman, *Assistant Professor of Surgery and Director of Vascular Surgery Research, UMDNJ–RWJMS; Ph.D., Albany Medical College*
Biomaterials and tissue engineering

Judith A. Neubauer, *Associate Professor of Medicine, UMDNJ–RWJMS; Ph.D., Rutgers*
Neuromodulation of central neurons

Patrick O'Connor, *Assistant Professor of Orthopaedics, UMDNJ–RWJMS; Ph.D., Columbia*
Biomaterials and tissue engineering

Thomas V. Papathomas, *Professor of Biomedical Engineering, SE; Ph.D., Columbia*
Motion, depth, and texture perception; visual pattern recognition

John R. Parsons, *Professor of Orthopaedics, UMDNJ–NJMS; Ph.D., Pennsylvania*
Biomechanics; biomaterials; orthopedic implant design; articular cartilage injury and biomechanics

E. Diane Rekow, *Professor and Chairperson, Department of Orthodontics, UMDNJ–NJDS; Ph.D., D.D.S., Minnesota*
Machinable ceramics; CAD/CAM for dental applications

John Ricci, *Associate Professor of Orthopaedics, UMDNJ–NJMS; Ph.D., UMDNJ*
Cell and tissue response to biomaterials and implantable biomedical devices

Alvin J. Salkind, *Professor of Surgery/Bioengineering, UMDNJ–RWJMS, and Professor of Biomedical Engineering, SE; D.Ch.E., Polytechnic Institute of New York*
Physiological sensors and stimulators; pacemakers; catheters

Kathryn Scarbrough, *Visiting Professor, SE; Ph.D., Maryland*
Integrative systems physiology

John Semmlow, *Professor of Biomedical Engineering, SE, and Professor of Surgery, UMDNJ–RWJMS; Ph.D., Illinois*
Neural control of eye movements; noninvasive detection of coronary artery disease

Troy Shinbrot, *Associate Research Professor, SE; Ph.D., Maryland*
Computational bioengineering; biomedical imaging

George K. Shoane, *Professor of Biomedical Engineering, SE; Ph.D., California (Berkeley)*
Visual control models; early visual processing, machine vision applications

David Shreiber, *Assistant Professor of Biomedical Engineering, SE; Ph.D., Pennsylvania*
Tissue engineering; injury biomechanics, nerve regeneration

Frederick H. Silver, *Professor of Pathology, UMDNJ–RWJMS; Ph.D., Massachusetts Institute of Technology*
Biomaterials; connective tissue structure and mechanics

Patrick Sinko, *Professor of Pharmaceutics, EMSP; Ph.D., Michigan*
Pharmacokinetics

Kathryn Uhrich, *Assistant Professor of Chemistry, FAS–NB; Ph.D., Cornell*
Biopolymer synthesis

William C. Van Buskirk, *Professor of Mechanical Engineering, Provost and Senior Vice President of Academic Affairs, NJIT; Ph.D., Stanford*
Bone mechanics; vestibular mechanics

Yehuda Vardi, *Professor of Statistics, FAS–NB; Ph.D., Cornell*
Positron emission tomography; operations research; applied probability and industrial statistics

Harvey R. Weiss, *Professor of Physiology, UMDNJ–RWJMS; Ph.D., Duke*
Circulatory and cardiac physiology

Joseph Wilder, *Research Professor of Electrical and Computer Engineering, SE; Ph.D., Pennsylvania*
Human visual perception

Martin Yarmush, *Professor of Biomedical Engineering and Professor of Chemical and Biochemical Engineering, SE; Ph.D., Rockefeller; M.D., Yale*
Tissue engineering, metabolic engineering, genomics and proteomics, stem-cell bioengineering

Mark C. Zimmerman, *Group Leader, Physical and Analytical Characterization, Johnson & Johnson; Ph.D., Rutgers*
Orthopedic biomaterials and biomechanics, acoustic microscopy

Associate Members of the Graduate Faculty

Kenneth J. Ciuffreda, *Professor of Vision Sciences, SUNY (College of Optometry); Ph.D., California (Berkeley)*
Clinical and research aspects of visual function and oculomotor control

Robert D. Harten, *Associate Professor of Orthopaedics, UMDNJ–RWJMS; Ph.D., Rutgers*
Orthopaedic biomechanics; bone repair; distraction osteogenesis, acoustic microscopy, tissue engineering

Robert M. Olson, *Associate Professor of Surgery, UMDNJ–RWJMS; M.D., Pennsylvania*
Wound healing; burns; collagen; synthetic skin; epithelialization

Steve Petrucelli, *Assistant Professor of Biomedical Engineering, SE; Ph.D., Rutgers*
Design of microcomputer base; analytical instrumentation

Adjunct Members of the Graduate Faculty

Glen Atlas, *Assistant Professor of Anesthesiology, UMDNJ–RWJMS; M.D., Rutgers*
Cardiovascular bioengineering

Carey Glass, *President, CG Medical, EMSP; B.S., New York*
Prosthetic materials and devices

George S. Tzanakos, *Visiting Associate Professor of Biomedical Engineering, SE; Ph.D., Syracuse*
Positron emission tomography (PET): R&D of new PET scanners and detectors, image reconstruction

Programs

The academic, research, and training activities of the graduate program in biomedical engineering are carried out by the faculties of the University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School in collaboration with the School of Engineering of Rutgers, located on the Busch campus in Piscataway, New Jersey.

The biomedical engineering faculty has established research programs in cardiovascular systems analysis; automated diagnostic devices; bioinstrumentation, including biotelemetry and implants; cardiac-assist devices; medical applications of pattern recognition; medical imaging; neural-network applications to biomedical engineering; neurological control; neuromuscular modeling; biomechanics; and biomaterials. Research areas in the medical school also include electroneurophysiology, neural information processing and modeling, hypertension, respiratory controls, computer-assisted diagnosis, nuclear magnetic resonance, positron-emission tomography, the study of binocular oculomotor balance, and the study of artificial-implant materials.

Minimum requirements for the M.S. degree include 38 credits of course work, 6 credits of research, and an M.S. thesis. Minimum requirements for a Ph.D. degree are 48 credits with satisfactory grades in approved courses and 24 credits for an acceptable research thesis. There is no foreign language requirement. The residence requirement depends on the area of specialization.

Students who have been accepted to both the Graduate School–New Brunswick and the University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School and who satisfy the requirements of both institutions are eligible to pursue an M.D./Ph.D. curriculum.

The qualifying examination normally consists of four written examinations. All students take examinations in both physiology and in the research area of their thesis. Depending on their concentration within the program, students take examinations in either (1) systems analysis and computer applications, and instrumentation or (2) biomaterials and biomechanics. An oral examination, in the appropriate area of specialization, is administered by the student's thesis committee. Candidates are required to present seminars, which are attended by all members of the thesis committee, in order to allow the committee to evaluate their research progress.

The program in biomedical engineering has been selected to participate in the Graduate Professional Opportunities Program, which provides fellowships for women and minority students.

Graduate Courses

16:125:503,504. THEORY AND DESIGN OF BIOMEDICAL INSTRUMENTS (3,3)
Semmlow
The principles of instrument-type transducer design, with illustrations of resistance, inductance, capacitance, piezoelectric, magnetostrictive, and force-balance-type transducers. Examples of stress instruments for medical applications.

16:125:505. (F) BIOPOLYMERS (3)
Silver. Prerequisite: Elementary biochemistry. Recommended: Physical chemistry.
Relationship among macromolecular structure, maintenance of tissue shape, and mechanical integrity, particularly in mammalian connective tissues. Emphasis on structural mechanisms related to viscoelastic behavior of collagen and matrix components, as well as rubberlike behavior of elastin. Laboratory demonstrations emphasize relationship of structure and physical properties of structural biomaterials.

16:125:506. (S) ARTIFICIAL IMPLANTABLE MATERIALS (3)
Silver. Prerequisite: Bachelor's degree in engineering or permission of instructors.
Evaluation of biocompatibility. Specific biomaterials-tissue interactions. Toxicology of implanted materials. Surface phenomenon and membranes. Implantable electrodes and power sources. Implantable metals, alloys, polymers, and ceramics. Lubrication and wear of implants. Total hip and knee prostheses. Connective tissue replacement.

16:125:507. (F) WAVE PHENOMENA IN BIOMEDICAL SYSTEMS (3)
Wave propagation in electrical, mechanical, thermal, and chemical systems; the common parameters of distributed systems; blood flow in arteries; chemical diffusion in organs; and nerve action potential transmission.

16:125:508. (S) PATHOBIOLOGY (3)
Silver. Prerequisites: 01 or 11:115:301 or equivalent, and permission of instructor.
Cellular and tissue reaction to injuries resulting from ischemia, physical forces, and exposure to chemicals, including synthetic and natural polymers. Inflammation, immune reactions, regeneration, and repair. Transplantation of natural and synthetic materials as well as reactions to implanted materials.

16:125:509. MEDICAL DEVICE DEVELOPMENT (3)
Development of medical devices that employ primarily polymeric materials in their construction. Materials selection, feasibility studies, prototype fabrication, functionality testing, prototype final selection, biocompatibility considerations, efficacy testing, sterilization validation, FDA regulatory approaches, writing of IDE, SID(K) and PMAs, device production, and record keeping.

16:125:510. (S) ENGINEERING HEMODYNAMICS (3)
Drzewiecki
Application of engineering techniques to the study of blood flow. Topics include the analysis of physiologically relevant models of the left ventricle, aorta, and peripheral vascular system in normal and diseased states. Analysis applied to the design of circulatory assist devices and cardiovascular instrumentation.

16:125:512. (S) FUNDAMENTALS OF COMPUTED TOMOGRAPHY (3)
Dunn. Prerequisite: 16:332:543.
Image restoration and enhancement techniques, convex projections, pseudo inverse, back projection, simplex methods, least mean square error, constrained solutions, nonlinearities. Applications include X ray, ultrasound, NMR, and optical medical imaging systems.

16:125:513. (S) VISUAL RESEARCH AND INSTRUMENTATION (3)
Shoane. Prerequisite: 14:332:345 or equivalent.
Control system analysis of human visual systems and survey of instrumentation used. Topics include anatomy of the visual system; triad: accommodation, vergence, and pupil; saccadic and pursuit eye movements.

16:125:515. (F) BIOELECTROCHEMICAL ASPECTS OF IMPLANTS AND DEVICES (3)
Guzelsu, Salkind. Prerequisites: 16:125:503, 504, and 507.
Applications of bioelectrochemical engineering to areas of biomedical engineering, including membrane properties, propagation of biological wave potentials, corrosion of implanted materials, and nerve and organ stimulation.

16:125:516. (S) VISUAL PATTERN RECOGNITION (3)
Micheli-Tzanakou. Prerequisites: 01:119:356 and 01:640:244, or equivalent.
Patterns are the means by which living organisms and "thinking" machines sense, interpret, classify, and act on information extracted from their surroundings. Recognition in the visual system within the context of information processing in living organisms and computers. Computer vision compared to biological vision.

16:125:517. (F) CIRCULATORY DYNAMICS (3)
Li
The circulatory system with emphasis on invasive and noninvasive measuring techniques. Topics include measurement of blood pressure and flow in arteries and veins, muscle mechanics, models of the heart, microcirculation, the closed cardiovascular system, and cardiac assist devices.

16:125:518. (S) COMPUTER APPLICATIONS IN BIOMEDICAL ENGINEERING (3)
Papathomas
Digital and other computer techniques applied to the problems of biomedicine. The acquisition of data and its processing with small computers. Modeling of biological and other systems.

16:125:519. (F) BIOLOGICAL MATERIALS (3)
Guzelsu. Prerequisite: Bachelor's degree in engineering.
Mechanical and electromechanical properties of biological tissues. Bone, tendon, cartilage, and soft tissues. Composite and mixture modeling. Experimental and theoretical determination of strain energy function. Biomimetics.

16:125:520. (S) NEUROELECTRIC SYSTEMS (3)
Micheli-Tzanakou. Prerequisites: 16:332:505 and general physiology.
Introduction to function and models of the nervous system; generator and action potentials; conduction in nerve fibers and across synaptic junctions; analysis of sensory and neuromuscular systems; EEG and EKG waveforms.

16:125:523. (F) BIOMEDICAL INSTRUMENTATION LABORATORY (3)
Li. Prerequisites: 16:125:503, 504.
Practical design of biomedical transducers, electrodes, amplifiers. Operation and performance evaluation of biomedical instruments. Recording, filtering, processing, and analysis of physiological signals.

16:125:525. (F) BIOLOGICAL CONTROL SYSTEMS (3)
Shoane. Prerequisite: 01:119:356 or equivalent.
Application of control theory to the analysis of physiological systems. Topics include pharmacokinetics, cardiovascular system, pulmonary system, stability analysis using Nyquist and root locus, LMS adaptive algorithm, renal concentrating mechanism, membrane potential, and ionic channels. Computer simulation exercises parallel each lecture topic.

16:125:526. BRAIN DYNAMICS (3)
Micheli-Tzanakou. Prerequisite: 16:125:520 or equivalent.
Combined analysis procedures of EEG and evoked potentials may provide information on signal neural events provided that experiments are adequately designed. Presents conceptual development of resonance phenomena in biophysical sciences and considers the system at moment of stimulation for estimating and predicting its response. Stereodynamics, simultaneously recorded multichannel EEG data, and evoked potentials from substructures of the brain.

16:125:528. (S) MOLECULAR SYSTEMS ENGINEERING (3)
Craelius. Prerequisites: Mammalian physiology and cell physiology.
Interfacing of biomolecules and biological tissues with useful devices. Principles of recording and analysis of molecular signals discussed. Modeling of molecular electronic systems using simulation software.

16:125:530. NONLINEAR BIODYNAMICS, CHAOS, AND FRACTALS (3)
Drzewiecki
Introduction to nonlinear dynamics and chaos, phase plots, strange attractors, deterministic/random fractals, fractal dimension. Applications in cardiopulmonary science and neurosciences.

16:125:531. (S) ELECTROMAGNETIC COMPATIBILITY (3)
Craelius
Medical applications of electromagnetic (EM) energy; principles of reducing EM emission and noise susceptibility of devices in the 25–1,000 MHz band; test and measurements of EM fields for regulatory compliance.

16:125:532. CYTOMECHANICS (3)
Craelius. Prerequisite: Undergraduate degree in engineering.
Mechanical properties and measurements of cells; stress-strain relationships in cells, organelles, and biomatrices, including methods of mechanical measurements.

16:125:533. DESIGN OF MICROPROCESSOR-BASED MEDICAL INSTRUMENTATION (3)
Petrucelli. Prerequisites: 16:125:504 and 14:332:374, or equivalent.
Signal processing, display, and control components of medical instrumentation systems. Topics include bus and communication protocols, microprocessor interface design, signal conditioning and acquisition circuitry, and data display interfaces.

16:125:540. (S) INTRODUCTION TO LIMB PROSTHETICS I (3)
Basics of prosthetic practice, ethics, health economics, and professionalism; neuropathology and orthopathology.

16:125:541. (F) BIOMECHANICAL MEASUREMENTS (3)
Craelius, Dunn
Techniques for measuring biomechanical properties of limbs, organs, and tissues, as well as prosthetic devices, both at rest and during ambulation. Topics include experimental and statistical methods, clinical-research study design, mechanical properties and behavior of tissues, use of transducers, and major imaging modalities.

16:125:542. (S) PROSTHETICS FOR THE UPPER LIMB (4)
Craelius
Material selection and mechanical-electrical design criteria for the upper-limb amputee. Design and fabrication of operational prostheses, starting from measurements of amputee subjects and finishing with operational testing.

16:125:543. (F) PROSTHETICS FOR THE LOWER LIMB I (4)
Craelius
Material selection and mechanical design criteria for the transtibial amputee. Design and fabrication of operational prostheses, starting from measurements of amputee subjects and finishing with operational testing. Bodily responses to amputation; casting; components; initial fitting; gait evaluation and training; pre- and postoperative care.

16:125:544. (S) PROSTHETICS FOR THE LOWER LIMB II (4)
Craelius
Material selection and mechanical design criteria for the transfemoral amputee. Design and fabrication of operational prostheses, starting from measurements of amputee subjects and finishing with operational testing. Bodily responses to amputation; casting; components; initial fitting; gait evaluation and training; pre- and postoperative care.

16:125:546. (S) SELF-ASSEMBLY PATTERN (3)
Shinbrot
For engineers who seek familiarity with and tools to analyze self-assembly of polymers, proteins, cells, and multicellular systems encountered in subfields ranging from tissue replacement therapies to polymeric drug delivery systems.

16:125:551. (F) BIOPOLYMER SYNTHESIS (3)
Kohn, Uhrich
Provides chemists, as well as chemical and biomedical engineers, with a solid understanding of the key principles that differentiate polymers as unique materials. Upon completion, students will be able to select polymers for industrial/medical applications, comprehend the scientific literature in polymer chemistry, and conduct applications-related research involving polymeric materials. Prior knowledge of polymer chemistry or materials science not required.

16:125:553. (F) BIOMATERIALS CHARACTERIZATION (3)
Moghe, Ricci
Provides fundamental instruction on the methods and rationales used in characterization of metal, ceramic, polymeric, and biologic materials used in biomedical implant fabrication. Instruction in microscopy and imaging techniques, spectroscopy and electron-probe methods, mechanical characterization, and models used to characterize cell and tissue response to biomaterials. Includes such topics as response of specific tissues to biomaterials, tissue engineering, and artificial organs.

16:125:562. DIGITAL RADIOLOGY (3)
Dunn
Models of image formation, part and process segmentation and recognition. Specialized models of living organisms. Structural and statistical models of form; reasoning and interpretation models of functions. Medical diagnosis. Artificial intelligence and computational biology.

16:125:571. (F) BIOSIGNAL PROCESSING (3)
Semmlow
Application of basic signal analysis to biological signals and the analysis of medical image. Extensive use of the MATLAB language in example and problems.

16:125:572. (S) BIOCONTROL, MODELING, AND COMPUTATION (3)
S. Dunn, Shoane
Application of control theory to the analysis of biological systems. As foundation for other biomedical engineering courses, topics include (biocontrol) control systems principles, Nyquist and root locus stability analysis; (modeling) Nernst membrane model, action potential, cardiac and vascular mechanics, accommodation and vergence eye movements, saccades, pharmacokinetic models; and numerical solutions to different equations, computer methods using C++, and image processing of biological systems.

16:125:573. (F) KINETICS, THERMODYNAMICS, AND TRANSPORT IN BIOMEDICINE (3)
Shinbrot
Intended for those seeking familiarity with the effects of, and tools to deal with, fluid, multiphase, chemical, and thermal transport and kinetics problems in biological systems.

16:125:574. (S) BIOMATERIALS AND BIOMECHANICS (3)
Harten
Foundation in basic engineering statistics, dynamics, and strength materials expected. These engineering concepts are applied to biologic tissues and the mechanics of musculoskeletal systems under both normal and pathologic conditions. Issues ranging from basic biocompatibility to engineered tissue replacements will be discussed.

16:125:601. JOURNAL CLUB AND SEMINAR (1)
For first-year graduate students.

16:125:602. SURVIVAL SKILLS AND SEMINAR (1)
For first-year graduate students.

16:125:603,604. SEMINAR IN BIOMEDICAL ENGINEERING III,IV (1,1)
For advanced graduate students.
Current topics in biomedical engineering discussed by invited speakers and in prepared presentations by students.

16:125:607,608. (F) TEACHING ASSISTANT TRAINING INTERNSHIP (1,1)
Langrana
All second year doctoral graduate students will take a yearlong teaching internship course. In the first term, students receive instructions in learning styles, teaching tools, and methodology. Most classes will feature one student who will present a topic in a one-on-many setting. This will be followed by constructive criticism by the participants, as well as feedback via videotape, a proven tool for self-improvement in teaching. In the second term, students will use these methods to teach undergraduates in the sophomore introductory laboratories.

16:125:610. ADVANCED TOPICS IN COMPUTERS IN BIOMEDICAL ENGINEERING (3)
Dunn. Prerequisites: 16:125:518 and permission of instructor.
Advanced study of computer applications in biomedical engineering. Possible topics include computerized axial tomography (CAT), positron emission tomography (PET), magnetic resonance imaging (MRI), use of artificial intelligence (AI) in medical diagnosis, learning systems, digital and sampled data implementations, large-scale systems, filtering, and image reconstruction. Topics vary.

16:125:612. ADVANCED TOPICS IN ENGINEERING HEMODYNAMICS (3)
Prerequisite: 16:125:510.
Emphasis on assisted circulation and artificial hearts, noninvasive indices of cardiac disorders and their measurement, and models of coronary circulation.

16:125:615. ADVANCED TOPICS IN BRAIN RESEARCH (3)
Papathomas. Prerequisites: 16:125:520 and permission of instructor.
Advanced study of current areas of brain research. Topics include information processing in the brain, pattern recognition in different sensory modalities, advanced techniques of diagnosing different system disorders, and data recording and techniques of analysis. Topics vary depending on student interest and faculty availability.

16:125:620. NEURAL NETWORKS AND NEUROCOMPUTING (3)
Micheli-Tzanakou. Prerequisites: Advanced standing and permission of instructor.
Classical theories such as the Perceptron; LMS algorithm; the Boltzmann machine; Hopfield nets; back propagation; associative neurons; as well as adaptive algorithms, such as the ALOPEX algorithms, examined in detail. Different applications and current literature examined and discussed.

16:125:621,622. SPECIAL PROBLEMS IN BIOMEDICAL ENGINEERING (BA,BA)

16:125:699. NONTHESIS STUDY (1)

16:125:701,702. RESEARCH IN BIOMEDICAL ENGINEERING (BA,BA)

See also courses listed under Electrical Engineering, as well as 16:650:518 Biomechanical Systems (3).

BIORESOURCE ENGINEERING 127

Degree Program Offered: **Master of Science**
Director of Graduate Program: **Professor Barbara J. Turpin,**
 Environmental Science Building, Cook Campus (732/932-9540)

Members of the Graduate Faculty

Arend-Jan Both, *Assistant Professor of Bioresource Engineering, CC;*
 Ph.D., Cornell
 Controlled-environment agriculture
Donna E. Fennell, *Assistant Professor of Environmental Engineering, CC;*
 Ph.D., Cornell
 Bioremediation; wastewater treatment; bioprocess modeling; anaerobic processes
Qingrong Huang, *Assistant Professor of Food Science, CC; Ph.D., Nebraska*
 Food delivery systems biochips and nanotechnology
Mukund V. Karwe, *Associate Professor of Food Science, CC; Ph.D., Rutgers*
 Food extension, baking health promotion through processed food
Uta Krogmann, *Associate Professor of Environmental Science, CC; Ph.D.,*
 Hamburg-Harburg
 Waste analysis, recycling, waste minimization, anaerobic digestion, composting
Sean X. Liu, *Assistant Professor of Food Engineering, CC; Ph.D., Kansas State*
 Membrane separations, solid-liquid mixings, nonotechnology
David R. Mears, *Professor of Bioresource Engineering, CC; Ph.D., Rutgers*
 Energy alternatives for agriculture; engineering greenhouse systems: solar and waste heat; mechanization
George H. Nieswand, *Professor of Environmental Systems Analysis, CC;*
 Ph.D., Rutgers
 Environmental systems analysis; water resource management; land-use planning
Christopher C. Obropta, *Assistant Professor of Environmental Science, CC;*
 Ph.D. Stevens
 Watershed management stormwater best management practices
Barbara J. Turpin, *Associate Professor of Environmental Science, CC;*
 Ph.D., Oregon Graduate Institute
 Air pollution instrumentation; sampling and analysis of atmospheric particles
Christopher G. Uchrin, *Professor of Environmental Science, CC; Ph.D. Michigan*
 Math modeling of contamination transport in surface and groundwater
Kit L. Yam, *Associate Professor of Food Science, CC; Ph.D. Michigan State*
 Food packaging engineering, polymeric material

Adjunct Members of the Graduate Faculty

James Cavazzoni, *Postdoctoral Associate; Ph.D., New York*
 Earth systems science and modeling; mathematical crop modeling and associated experimentation
Robert M. Cowan, *Adjunct Professor of Environmental Science, CC;*
 Ph.D., SUNY (Buffalo)
 Biological treatment (kinetics, process engineering, modeling); bioremediation, industrial and hazardous-waste treatment
Andrew J. Higgins, *Vice President for Engineering, Applied Waste Water Tech., Inc.; Ph.D., Rutgers*
 Wastewater process engineering; solid waste recycling and utilization; hazardous waste
Sukwon Kang, *Postdoctoral Associate; Ph.D., Cornell*
 Systems analysis and modeling in plant growth, food processing, and waste man - agement; heat and mass transfer in foods; geographic information systems; instru - mentation and sensing
Tadashi Takakura, *Professor of Agricultural Engineering, University of Tokyo; Ph.D., Tokyo*
 Environmental control engineering

Programs

Bioresource engineering applies the principles of engineering and technology to the production, processing, and handling of food and natural fiber. It deals with basic research and biological and engineering applications in such fields as the conservation of natural resources, irrigation and drainage, the quality of surface and groundwater, and land-use planning. Other topics include processing and storage techniques, fundamental studies of the engineering properties of biological materials, the effects of biological waste-systems on the environment, the design and development of machines and buildings, and automation in greenhouse crop-production systems and the food industry. There are no language or residency requirements.

Graduate Courses

16:127:507. (F) Environmental Systems Analysis (3)
Nieswand
Philosophy of the systems approach. The modeling of systems. Quantitative methods in environmental systems analysis. Application of the systems approach and techniques of systems analysis to environmental problems.

16:127:508. (S) Instruments in Bioresource Engineering (3)
General measurement systems, error analysis, transducer and signal conditioning. Digital data-acquisition and control systems.

16:127:611,612. Seminar in Bioresource Engineering (1,1)
Turpin

16:127:697,698. Special Problems in Bioresource Engineering I,II (BA,BA)
Directed studies of special problems that involve unique applications of bioresource engineering.

16:127:699. Nonthesis Study (1)

16:127:701,702. Research in Bioresource Engineering (BA,BA)

BIOTECHNOLOGY 126

Program Offered: **Core Curriculum in Biotechnology**
Directors of Interdisciplinary Core Curriculum: **Professor Henrik Pedersen**, Department of Chemical and Biochemical Engineering, Busch Campus (732/445-2568, 5514); **Professor Aaron J. Shatkin**, Center for Advanced Biotechnology and Medicine, Busch Campus (732/235-5310)

Participating Faculty

The following members of the graduate faculty, identified more fully under the subject headings indicated, are affiliated with the core curriculum in biotechnology:

Cory Abate-Shen, *Physiology and Neurobiology*
Edward Arnold, *Chemistry and Chemical Biology*
Helen Berman, *Chemistry and Chemical Biology*
Kenneth J. Breslauer, *Chemistry and Chemical Biology*
Helen M. Buettner, *Chemical and Biochemical Engineering*
William Craelius, *Biomedical Engineering*
Stanley Dunn, *Biomedical Engineering*
Richard H. Ebright, *Chemistry and Molecular Genetics*
Douglas E. Eveleigh, *Microbiology and Molecular Genetics*
Celine Gelinas, *Microbiology and Molecular Genetics*
Benjamin J. Glasser, *Chemical and Biochemical Engineering*
Max Haggblom, *Microbiology and Molecular Genetics*
Masayori Inouye, *Biochemistry*
Joachim Kohn, *Chemistry and Chemical Biology*
Debra Laskin, *Toxicology*
Michael J. Leibowitz, *Microbiology and Molecular Genetics*
Peter Lobel, *Pharmacology*
Kim S. McKim, *Microbiology and Molecular Genetics*
Joachim Messing, *Microbiology and Molecular Genetics*
Prabhas Moghe, *Chemical and Biochemical Engineering*
Gaetano T. Montelione, *Biochemistry*
Fernando Muzzio, *Chemical and Biochemical Engineering*
Henrik Pedersen, *Chemical and Biochemical Engineering*
David J. Riley, *Physiology and Neurobiology*
Charles M. Roth, *Chemical and Biochemical Engineering*
Aaron J. Shatkin, *Microbiology and Molecular Genetics*
David Shreiber, *Biomedical Engineering*
Ann M. Stock, *Biochemistry*
Kathryn Uhrich, *Chemistry and Chemical Biology*
Eileen White, *Microbiology and Molecular Genetics*
Martin L. Yarmush, *Biomedical Engineering*
Gerben J. Zylstra, *Microbiology and Molecular Genetics*

Core Curriculum Program

The biotechnology core curriculum provides predoctoral students with an integrated, interdisciplinary education in biotechnology. Students apply to the core curriculum after they have been admitted as full-time students in any of the biological, physical, or mathematical science doctoral programs in the Graduate School–New Brunswick. Upon graduation, students within the core curriculum receive a Ph.D. in their primary field (e.g., microbiology, biochemistry, chemical engineering) with specialization in biotechnology. Because of the interdisciplinary nature of the subject matter, the program has specific course guidelines, laboratory rotations, and seminars. These features ensure that students not only receive a solid education in their core disciplines, but also that they graduate with the cross-disciplinary skills needed to translate basic-science discoveries into technological applications.

The course structure is flexible. Formal course requirements include a minimum of 6 credits in molecular and cellular biology, 3 credits in biophysical chemistry, and 3 credits in engineering or computer science. During each term they are enrolled, all students must complete two laboratory rotations and enroll in 16:126:603,604 Topics in Advanced Biotechnology. The laboratory rotation gives students broader exposure to the methods of biotechnology. The topics course, on the other hand, provides students with in-depth exposure to developments in biotechnology and gives them more opportunity to interact with faculty members. Students work closely with a faculty mentor from the participating faculty list on a dissertation topic. The research training focuses on protein production, tissue engineering, drug design and delivery, and biomolecular engineering. Students in the core curriculum are expected to have a science background that includes one year of college mathematics, one year of biology, three years of chemistry (general, organic, physical), and one year of physics.

Graduate Courses

16:126:603,604. Topics in Advanced Biotechnology (1,1)
Oral presentations and discussions of the current literature in biotechnology.

CELL AND DEVELOPMENTAL BIOLOGY 148

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Richard W. Padgett**, Nelson Biology Laboratories, Busch Campus (732/445-3430)

Members of the Graduate Faculty

Cory Abate-Shen, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS/CABM; Ph.D., Cornell Medical College*
Molecular processes that control gene expression in vertebrate development and oncogenesis
Stephen Anderson, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Harvard*
Proteases and protease inhibitors; protein folding; molecular recognition; structural bioinformatics
Bruce S. Babiarz, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Cincinnati*
Early mammalian development, implantation; mammalian developmental genetics
Gary Brewer, *Associate Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; Ph.D., Auburn*
Posttranscriptional control of gene expression in disease
Steven Brill, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., SUNY (Stony Brook)*
Eukaryotic DNA replication and genome stability
Salvatore J. Caradonna, *Associate Professor and Chairperson of the Department of Molecular Biology, UMDNJ–SOM; Ph.D., SUNY (Buffalo)*
Molecular biology of human DNA repair; interactions with cell cycle control elements
Kiran K. Chada, *Professor of Biochemistry, UMDNJ–RWJMS; Ph.D., Oxford*
Developmental gene expression in transgenic mice
Kuang Yu Chen, *Professor of Chemistry, FAS–NB; Ph.D., Yale*
Biochemistry and function of polyamines and hypusine-containing eIF-5A, cancer biology; transcription factors and cellular senescence
Suzie Chen, *Associate Professor of Chemical Biology and Pharmacognosy, EMSP; Ph.D., Albert Einstein College of Medicine*
Transgenic mice predisposed to melanoma development; molecular merchant of adipocyte differentiation; uu-inducible genes
Xuemei Chen, *Assistant Professor of Genetics, WIM/FAS–NB; Ph.D., Cornell*
Molecular genetic analysis of flower development in **Arabidopsis**

Lori Covey, *Associate Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Columbia*
Switch recombination in human B lymphocytes in response to T-cell factors

Bill D. Davis, *Associate Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Purdue*
Science education; plant biology

Robin L. Davis, *Associate Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Stanford*
Regeneration and electrophysiology of peripheral auditory neurons

David T. Denhardt, *Professor of Cell and Molecular Biology, FAS–NB; Ph.D., California Institute of Technology*
Molecular biology of cancer, cell signaling and regulation of gene expression; structure and function of osteopontin and tissue inhibitor or metalloproteinases

Emmet A. Dennis, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Connecticut*
Parasitology, schistosome pathology

Emanuel DiCicco-Bloom, *Associate Professor of Cell Biology and Neuroscience, UMDNJ–RWJMS; M.D., Cornell*
Regulation of developmental and adult neurogenesis

Cheryl Dreyfus, *Professor of Cell Biology and Neuroscience, UMDNJ–RWJMS; Ph.D., Cornell*
Role of environmental factors on brain neuron ontogeny and glial

Monica Driscoll, *Professor of Molecular Biology and Biochemistry, CABM; Ph.D., Harvard*
Molecular genetics of degenerative cell death; mechanical signaling

Isaac Edery, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB/CABM; Ph.D., McGill*
Molecular and cellular mechanisms underlying biological clocks

M. David Egger, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS; Ph.D., Yale*
Neurophysiology; neuroanatomy; neurogenetics

Francine B. Essien, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Albert Einstein College of Medicine*
Developmental biology; genetics

Bonnie Firestein, *Assistant Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., California (San Diego)*
Targeting of neuronal proteins

Joseph Fondell, *Assistant Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., SUNY (Stony Brook)*
Regulation of gene expression by nuclear hormone receptors

Dunne Fong, *Associate Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Princeton*
Cell differentiation: proteinases and cancer invasion

Ramsey Foty, *Assistant Professor of Surgery, UMDNJ–RWJMS; Ph.D., Toronto*
Cancer, cadherins, catenins, cohesivity, invasion, metastasis, biophysics

Abram Gabriel, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB; M.D., Johns Hopkins*
Mechanisms of retrotransposon replication; chromosomal rearrangements

Donald Gerecke, *Assistant Professor of Pharmacology and Toxicology, EMSP; Ph.D., Harvard*
Molecular biology of lung fibrosis

Marion Gordon, *Associate Professor of Pharmacology and Toxicology, EMSP; Ph.D., UMDNJ/Rutgers*
Collagen gene regulation during cornea development; regulation and function of EMMPRIN, a matrix metalloproteinase stimulator, in normal and transformed cells

David Gorski, *Assistant Professor of Surgery, UMDNJ–RWJMS; Ph.D., Case Western Reserve*
Homeobox genes in tumor biology; angiogenesis inhibition in tumor therapy

Barth Grant, *Assistant Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Princeton*
Endocytosis in **C. elegans**

Martin Grumet, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Johns Hopkins*
Molecular mechanisms of cell adhesion in the nervous system

Samuel Gunderson, *Assistant Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Wisconsin*
Regulation of polyadenylation, RNA-protein interactions

Beatrice Haimovich, *Associate Professor of Surgery, UMDNJ–RWJMS; Ph.D., Pennsylvania*
Cell-surface interaction; adhesion receptors mediated signals

Nathan H. Hart, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Harvard*
Sperm egg interactions: egg activation; role of cytoskeleton in early embryogenesis

Ronald Hart, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Michigan*
Neuroimmunology of central nervous system injury

Robert Herman, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Rutgers*
Parasitology

Sarah Hitchcock-DeGregori, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS; Ph.D., Case Western Reserve*
Structure-function relationships in contractile proteins

Shu-Chan Hsu, *Assistant Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., British Columbia*
Molecular mechanisms of synaptic development and function

Arnold G. Hyndman, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., California (Los Angeles)*
Developmental neurobiology; neurotoxicology

Masayori Inouye, *Professor of Biochemistry, UMDNJ–RWJMS; Ph.D., Osaka*
Gene regulation; signal transduction; protein folding; adaptation to stresses

Kenneth Irvine, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB/WIM; Ph.D., Stanford*
Cell communication, patterning, and morphogenesis

William G. Johnson, *Professor of Neurology, UMDNJ–RWJMS; M.D., Columbia*
Genetics of human neurodegenerative diseases and developmental disorders

Megerditch Kiledjian, *Associate Professor ofCell Biology and Neuroscience, UMDNJ–RWJMS; Ph.D., Pennsylvania*
RNA-protein interactions in the eukaryotic gene expression

Tony Ah-Ng Kong, *Professor of Pharmaceutics, EMSP; Ph.D., SUNY (Buffalo)*
Pharmacogenomics and toxicogenomics of cancer chemopreventative compounds

George M. Krauthamer, *Professor Emeritus of Cell Biology and Neuroscience, UMDNJ–RWJMS; Ph.D., New York*
Neurophysiology; neuroanatomy

Eric Lam, *Professor of Plant Science, BCAE/CC; Ph.D., California (Berkeley)*
Plant gene targeting; programmed cell death; chromatin imaging

Jerome A. Langer, *Associate Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; Ph.D., Yale*
Cloning and analysis of cell surface receptors for alpha interferon; mechanism of action of interferons; protein recognition; receptors

Debra L. Laskin, *Professor of Pharmacology and Toxicology, EMSP; Ph.D., Medical College of Virginia*
Immunology; inflammation; toxicology; cytokinesis

Hsin-Yi Lee, *Professor of Biological Sciences, FAS–C; Ph.D., Minnesota*
Developmental biology; tissue culture

John Lenard, *Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., Cornell*
Cholesterol and steroid hormone endocrinology in **C. elegans**

Alice Y.-C. Liu, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Mount Sinai*
Stress, aging, and the role of redox in cell signaling and regulation

Fang Liu, *Assistant Professor of Chemical Biology, EMSP/CABM; Ph.D., Harvard*
Growth and differential control

Peter Lobel, *Professor of Pharmacology, UMDNJ–RWJMS/CABM; Ph.D., Columbia*
Lysomal enzymes and human hereditary diseases; mannose 6-phosphate receptors

Richard A. Lutz, *Professor of Marine and Coastal Sciences, CC; Ph.D., Maine*
Biology of deep-sea hydrothermal vents; molluscan ecology

Charles Martin, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Florida State*
Genetic control of membrane assembly

Fumio Matsumura, *Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Nagoya*
Molecular and cell biology of cytokinesis

Michael McCormack, *Professor of Pathology, UMDNJ–SOM; Ph.D., Minnesota*
Human genetics; behavioral genetics; biochemical genetics; genetic counseling

Terry R. McGuire, *Associate Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Illinois*
Behavioral and neurogenetics; biometrical genetics

Kim S. McKim, *Associate Professor of Genetics, CC/WIM; Ph.D., British Columbia*
Regulation of meiotic recombination; homologous chromosome pairing; DNA repair

Randall D. McKinnon, *Associate Professor of Neurosurgery, UMDNJ–RWJMS; Ph.D., McMaster*
CNS development and myelination; growth factors and signal transduction; cell transplantation; gene therapy for CNS tumors

Sally Meiners, *Assistant Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Michigan State*
Cell-surface interaction: adhesion receptors, mediated signals

Gary F. Merrill, *Professor of Physiology, Cell Biology, and Neuroscience, FAS–NB; Ph.D., Michigan State*
Organ perfusion; roles of naturally occurring chemicals in regulation of heart and skeletal muscle

Joachim Messing, *University Professor of Molecular Biology, WIM/FAS–NB; Ph.D., Munich*
Plant molecular biology

James Millonig, *Assistant Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS/CABM; Ph.D., Princeton*
Mouse genetics, dorsal CNS development, transcriptional regulation and neuroanatomy

Prabhas Moghe, *Associate Professor of Chemical and Biochemical Engineering, SE; Ph.D., Minnesota*
Bioengineering; microarchitecture of polymeric tissue analogs; tissue engineering of liver and skin; cell-biomaterial interactions and cell stress engineering during vascular reconstruction

N. Ronald Morris, *Professor of Pharmacology, UMDNJ–RWJMS; M.D., Yale*
Molecular biology of mitosis

William R. Moyle, *Professor of Obstetrics and Gynecology, UMDNJ–RWJMS;*
Ph.D., Harvard
Molecular biology of hormone action; structure and function of protein hormones
and their receptors

Robert G. Nagele, *Associate Professor of Molecular Biology, UMDNJ–SOM;*
Ph.D., Rutgers
Chromatin organization in the cell nucleus

Richard S. Nowakowski, *Associate Professor of Anatomy, UMDNJ–RWJMS;*
Ph.D., Harvard
Cell proliferation and migration during the early development of central
nervous system

Richard W. Padgett, *Professor of Molecular Biology and Biochemistry, WIM/*
FAS–NB; Ph.D., North Carolina (Chapel Hill)
Molecular genetics of development in **Drosophila** *and* **C. elegans**

Howard C. Passmore, Jr., *Professor of Genetics, FAS–NB; Ph.D., Michigan*
Mammalian genetics

Garth Patterson, *Assistant Professor of Molecular Biology and Biochemistry,*
FAS–NB; Ph.D., Oregon
Development, signal transduction, genetics, gene expression, aging

Isaac Peng, *Assistant Professor of Neuroscience, UMDNJ–RWJMS; Ph.D., Temple*
Actin and the cytoskeleton

Claudio Pikielny, *Assistant Professor of Neuroscience and Cell Biology,*
UMDNJ–RWJMS; Ph.D., Brandeis
Cellular and molecular mechanisms of olfaction; taste and response to pheromones
in the fruit fly **Drosophila**

John Pintar, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS;*
Ph.D., Oregon
Genetic analysis of mammalian growth and neuroendocrine development

Mark R. Plummer, *Associate Professor of Cell Biology and Neuroscience, FAS–NB;*
Ph.D., Stanford
Pharmacology and kinetic studies of neuronal calcium channels and
synaptic plasticity

Jamshid Rabii, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D.,*
California (San Francisco)
Neuroendocrinology; dynamics of brain-pituitary axis

Cordelia Rauskolb, *Research Assistant Professor, WIM; Ph.D., Princeton*
Regulation and mechanism of segmentation during **Drosophila** *development*

Yacov Ron, *Associate Professor of Molecular Genetics and Microbiology,*
UMDNJ–RWJMS; Ph.D., Weizmann Institute of Science
Gene therapy approaches for treatment of autoimmune diseases; development
of T and B cells

Christopher Rongo, *Assistant Professor of Genetics, WIM/FAS–NB;*
Ph.D., Massachusetts Institute of Technology
Synapse formation in the **C. elegans** *nervous system*

Charles Roth, *Assistant Professor of Chemical and Biochemical Engineering, SE;*
Ph.D., Pennsylvania
Molecular bioengineering

Alexey G. Ryazanov, *Associate Professor of Pharmacology,*
UMDNJ–RWJMS/CINJ; Ph.D., Moscow
Regulation of protein synthesis and the cell cycle

David Seiden, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS;*
Ph.D., Temple
Skeletal and cardiac muscle

Konstantin Severinov, *Associate Professor of Genetics, FAS–NB;*
Ph.D., Russian Academy of Sciences
Structure and function of RNApolymerases from eubacteria and yeasts

Daniel Shain, *Assistant Professor of Biology, FAS–C; Ph.D., Colorado State*
Molecular and cellular development of annelids

Aaron Shatkin, *Professor of Molecular Genetics and Microbiology,*
UMDNJ–RWJMS; University Professor of Molecular Biology, Rutgers; Director
of the Center for Advanced Biotechnology and Medicine; Ph.D., Rockefeller
Eukaryotic gene expression; viral cytopathogenesis

Michael M. Shen, *Associate Professor of Pediatrics, UMDNJ–RWJMS/CABM/*
CINJ; Ph.D., Cambridge
Growth factor signaling in and pattern formation in mouse embryo genesis;
prostate development and cancer

Andrew Singson, *Assistant Professor of Genetics, FAS–NB/WIM;*
Ph.D., California (San Diego)
Reproductive biology and cell-cell interactions in **C. elegans**

Ruth Steward, *Professor of Molecular Biology and Biochemistry, WIM/FAS–NB;*
Ph.D., Basel
Nuclear migration, RNAlocalization, and patterning in **Drosophila**

Ann Stock, *Associate Professor of Biochemistry, UMDNJ–RWJMS/CABM;*
Ph.D., California (Berkeley)
Structure and function of signal transduction proteins

Robert Trelstad, *Chairperson and Professor of Pathology, UMDNJ–RWJMS;*
M.D., Harvard
Morphogenesis; patterning mechanisms; medical informatics

Richard E. Triemer, *Professor and Chair of Cell Biology and Neuroscience,*
FAS–NB; Ph.D., North Carolina
Cellular, molecular, and evolutionary biology of protists

Chih-Cheng Tsai, *Assistant Professor of Physiology and Biophysics,*
UMDNJ–RWJMS; Ph.D., SUNY (Stony Brook)
Transcriptional regulation, nuclear receptor corepressors, **Drosophila** *development*

Aurea C. Vasconcelos, *Professor of Cell Biology and Neuroscience, FAS–NB;*
Ph.D., Chicago
Cell biology; plant molecular biology; chloroplast development, function, and reg -
ulation; carbohydrate metabolism

Andrew K. Vershon, *Professor of Molecular Biology and Biochemistry,*
WIM/FAS–NB; Ph.D., Massachusetts Institute of Technology
Regulation of transcription in the yeast **S. cerevisiae**

William G. Wadsworth, *Associate Professor of Pathology,*
UMDNJ–RWJMS/CABM; Ph.D., Missouri (Columbia)
Extracellular matrix and the guidance of cell migrations in **C. elegans**

Nancy Walworth, *Associate Professor of Pharmacology, UMDNJ–RWJMS;*
Ph.D., Yale
Regulation of cell cycle progression in eukaryotic cells

Eileen White, *Professor of Molecular Biology and Biochemistry, FAS–NB/CABM;*
Ph.D., SUNY (Stony Brook)
Regulation of programmed cell death (apoptosis) by viral oncogenes and tumor
suppressor genes

Frank J. Wilson, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS;*
Ph.D., Pittsburgh
Functions of motility-related proteins in muscle and nonmuscle systems

Donald A. Winkelmann, *Associate Professor of Pathology, UMDNJ–RWJMS;*
Ph.D., Wisconsin (Madison)
Macromolecular structure and assembly; molecular motor dynamics

Mengqing Xiang, *Associate Professor of Pediatrics, UMDNJ–RWJMS/CABM;*
Ph.D., Texas
Molecular mechanisms of neurosensory development

Chung S. Yang, *Professor of Pharmacognosy, EMSP; Ph.D., Cornell*
Mechanisms of drug metabolism and toxicity; molecular changes in carcinogene -
sis and their inhibition by dietary constituents

Wise Young, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Iowa;*
M.D., Stanford
Spinal cord nerve regeneration

Peter D. Yurchenco, *Professor of Pathology and Laboratory Medicine,*
UMDNJ–RWJMS; M.D., Ph.D., Albert Einstein College of Medicine
Basement membrane assembly and structure; biochemistry cell biology and molec -
ular genetic approaches

James Q. Zheng, *Associate Professor of Neuroscience and Cell Biology,*
UMDNJ–RWJMS; Ph.D., Tsinghua
Molecular/cellular mechanisms underlying the formation of neuronal circuitry

Renping Zhou, *Associate Professor of Chemical Biology, EMSP/EOHSI;*
Ph.D., California (Berkeley)
Molecular biology of axonal guidance and neural map formation

Associate Members of the Graduate Faculty

Rocco V. Carsia, *Associate Professor of Cell Biology, UMDNJ–SOM;*
Ph.D., Rutgers
Adrenocortical cell physiology

Julie M. Fagan, *Professor of Animal Sciences, CC; Ph.D., Arizona*
Mechanisms of protein breakdown in mammalian cells; muscle growth; molecular,
cellular, and immunological studies of proteinases and their inhibitors in health
and in disease

Dennis J. Joslyn, *Professor of Zoology, FAS–C; Ph.D., Illinois*
Insect cytogenetics

Leonard Sciorra, *Professor of Obstetrics/Gynecology and Reproductive Sciences,*
UMDNJ–RWJMS; Ph.D., Hahnemann
Human cytogenetics; fluorescent **in situ** *hybridization; chromosome structure*

Kathleen M. Scott, *Associate Professor of Biological Sciences, FAS–NB; Ph.D., Yale*
Mammalogy; vertebrate paleontology; functional morphology

Programs

The graduate program in cell and developmental biology is part
of a diverse, interactive community of biological scientists working
at Rutgers and at the University of Medicine and Dentistry of New
Jersey–Robert Wood Johnson Medical School. The graduate pro-
gram has approximately one hundred faculty members from the
two universities. Faculty research spans the fields of molecular,
cellular, and developmental biology. Researchers draw upon
diverse experimental systems to study such subjects as develop-
mental, human, and molecular genetics; signal transduction and
regulation of gene expression; developmental biology; regulation,
structure, and function of the cytoskeleton; parasitology; cellular
and molecular endocrinology; ultrastructural and molecular analy -
sis of mammalian cells; and neurobiology.

Applicants are expected to have had one year each of undergraduate mathematics, chemistry, and physics and two years of biology-related courses. Those who lack some of these prerequisites may complete them (without graduate credit) after admission to the program. Undergraduate concentrations in biology or other life sciences and research experience are desirable but not necessary. The graduate program in cell and developmental biology offers advanced studies leading to the M.S. and Ph.D. degrees. Classroom instruction combines a core of courses in biochemistry and molecular biology, molecular genetics, cell biology, and developmental biology, with area courses aimed at a student's specialty. Other graduate-level courses at Rutgers and UMDNJ–RWJMS provide training in such related areas as neurobiology, immunology, biostatics, computer science, and systems physiology. The goal of the program is to provide a challenging and rewarding environment in which students can develop fully their research and teaching skills.*

While requirements for the Ph.D. students may vary with the area of specialization, all students are expected to complete certain courses during their first two years in the program. This core curriculum includes biochemistry, molecular genetics, cell biology, developmental biology, and laboratory rotation. For advanced graduate students, the program offers special topic courses in cell and developmental biology. The minimum requirement for the Ph.D. degree is 72 credits. To qualify as a candidate for a Ph.D. degree, a student must pass a written comprehensive examination, make an acceptable oral presentation, and successfully defend a research proposal before a graduate faculty committee. A minimum of one academic year in residence is required. The program has no foreign language requirement.

Students may pursue a master's degree with or without writing a thesis. The requirement for the degree without thesis is 30 credits of course work. This includes a minimum of 1 credit of 16:148:509,510 Advanced Problems in Biology and the acceptance of the student's library or research project by a committee of three program faculty members. The requirements for the M.S. degree with thesis are a minimum of 24 course credits, 6 credits of research, and the satisfactory completion and defense of the thesis. All students must maintain a cumulative grade-point average of 3.0 or better to remain in the program.

Teaching assistantships are available for first-year and advanced graduate students. The program also offers fellowships to outstanding applicants. Joint Ph.D. degrees are available in this program. Further information about these may be found in the Degree Programs Available chapter.

Graduate Courses

16:148:503. (F) CELLULAR AND MOLECULAR SIGNALING (3)
Moyle. Prerequisite: General biochemistry.
Signal/transduction at the molecular level. Use of newer research techniques emphasized.

16:148:504. (S) DEVELOPMENTAL BIOLOGY (3)
Babiarz
Mechanisms responsible for the morphogenetic changes that occur during development of selected vertebrates and invertebrates. The role of intercellular communication in development, including mechanisms of action of receptors and cell-adhesion proteins needed for this process.

16:148:507. (F) IMMUNITY TO ANIMAL PARASITES (3)
Herman
Various aspects of natural and acquired humoral and cellular immune mechanisms operative in humans and other hosts against protozoan and helminth parasites. The effects of immunosuppression, antigenic variation, and stage-specific immunity in experimental parasitic infections.

* Admission is offered by the consolidated graduate programs in molecular biosciences. For further information, refer to the Molecular Biosciences heading within this chapter.

16:148:509,510. ADVANCED PROBLEMS IN BIOLOGY (BA,BA)
Required for nonthesis master's degrees. Also may be used for independent study. Prerequisite: Permission of graduate director.
Meets the needs of individual students.

16:148:514. (F) MOLECULAR BIOLOGY OF CELLS (3)
Denhardt. Prerequisites: 01:119:380 and 460, or equivalents. Corequisite: Graduate course in biochemistry.
Fundamentals of the molecular organization and functions of cells.

16:148:517. CELLULAR AND MOLECULAR MECHANISMS OF DISEASE (3)
Theories on the cellular and molecular mechanisms that underlie the development and progression of human diseases. Cell injury, inflammation, regeneration and repair, neoplasia, immune protection and immune disorders, environmental disorders, vascular diseases, connective tissue disorders.

16:148:530. (S) HUMAN GENETICS (3)
Passmore. Prerequisite: Basic molecular genetics. Recommended: Biochemistry and physiology.
Examination of molecular and chromosomal bases for human inherited diseases. Molecular approaches to gene identification, including position cloning and linkage analysis. Role of mutations, evaluation of repetitive sequences in the human genome.

16:148:534. (S) CYTOGENETIC ANALYSIS (4)
Sciorra
Covers field of eukaryotic chromosome analysis from standpoint of development and application of various techniques to the elucidation of chromosome structure, organization, and function. Examples taken largely from mammalian and human material. Some emphasis on human molecular cytogenetics and the phenotypic manifestations of chromosomal aberrations.

16:148:547,548. CURRENT TOPICS IN ENDOCRINOLOGY (1,1)
Prerequisite: Permission of instructor. Course may be repeated for credit.
Biochemical, physiological, and biological aspects of important current topics of endocrine research as reflected in recent journal articles. Topics vary to reflect the state of endocrine research.

16:148:550. (S) ADVANCED DEVELOPMENTAL BIOLOGY (3)
Steward. Prerequisite: 16:148:514 or equivalent or permission of instructor. Suggested: Genetics. Also open to advanced undergraduates.
Molecular mechanisms of cell type differentiation and body part specification. Cell-cell interaction, signal transduction during development, morphogenetic gradients, pattern formation, focusing on three experimental organisms: the nematode *C. elegans, Drosophila,* and the mouse. Genetic experimental approaches will be emphasized.

16:148:555. (F) CELL BIOLOGY AND HISTOLOGY (4)
Wilson. Lec. 3 hrs., lab. 3 hrs. Prerequisite: Permission of instructor.
Study of microscopic structure of cells, tissues, and organs as seen in the light and electron microscopes. Emphasis on correlation of structure and function.

16:148:565. (F) GROSS AND DEVELOPMENTAL ANATOMY (7)
Seiden, et al. Lec. 4 hrs., lab. 8 hrs. Prerequisite: Permission of instructor.
Study of macroscopic structure of the human body by dissection and other methods with reference to functional mechanisms and changes during development and clinical correlations.

16:148:581. (F) IMMUNOGENETICS (3)
Passmore. Prerequisites: Immunology, genetics, or permission of instructor.
Examination of the genetic control of antibody structure, immune response, graft rejection, and cell surface antigens. The use of immunology as a tool in genetic research.

16:148:591. (F) IMMUNOLOGY: CELLULAR AND MOLECULAR (3)
Covey. Prerequisite: Basic immunology.
Development of humoral and cell mediated immune systems.

16:148:598. SEMINAR IN CELL AND DEVELOPMENTAL BIOLOGY (1)
Student, staff, and guest lectures on current topics in cell and developmental biology.

16:148:600 THROUGH 605. SELECTED TOPICS IN CELL AND DEVELOPMENTAL BIOLOGY (1 EACH)
Prerequisites: 16:148:514, 550.
Advanced study of rapidly emerging areas in cell and developmental biology.

16:148:610,611. LABORATORY ROTATION (1.5,1.5)
Laboratory research for incoming students.

16:148:652. CURRENT CELL BIOLOGY (3)
Moyle
Analyses of progress in all areas of cell biology.

16:148:701,702. RESEARCH IN BIOLOGY (BA,BA)

CELLULAR AND MOLECULAR PHARMACOLOGY
(See Pharmacology, Cellular and Molecular 718)

CERAMIC AND MATERIALS SCIENCE AND ENGINEERING 150

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Lisa C. Klein, A225**
  Engineering Building, Busch Campus (732/445-2096)
  Web Site: *http://ceramicmaterials.rutgers.edu*

Members of the Graduate Faculty

W. Roger Cannon, *Professor of Ceramic and Materials Engineering, SE; Ph.D., Stanford*
  Mechanical properties; tape casting; sintering; Raman stress measurement
Manish Chhowalla, *Assistant Professor of Ceramic and Materials Engineering, SE; Ph.D., Cambridge*
  Carbon nanotubes; amorphous carbon; nanotubes for field emission
Frederic Cosandey, *Professor of Ceramic and Materials Engineering, SE; Ph.D., Carnegie Mellon*
  Electron microscopy; texture analysis; semiconductor sensors
Stephen C. Danforth, *Professor and Chairperson of the Department of Ceramic and Materials Engineering, SE; Ph.D., Brown*
  Solid free-form fabrication; fused deposition; microstructure/property relationships
Stephen H. Garofalini, *Professor of Ceramic and Materials Engineering, SE; Ph.D., Stanford*
  Molecular dynamics simulations; surface physics; structure and properties of glass surfaces; diffusion in glasses; intergranular films
Victor A. Greenhut, *Professor of Ceramic and Materials Engineering, SE; Ph.D., Rutgers*
  Structure-property relations; bonding and joining ceramics; glass to metals; failure analysis; chemomechanical polishing
Richard A. Haber, *Associate Professor of Ceramic and Materials Engineering, SE; Ph.D., Rutgers*
  Slip casting; rheology; whitewares
James A. Harrington, *Professor of Ceramic and Materials Engineering, SE; Ph.D., Northwestern*
  Specialty fiber optics; delivery systems for laser surgery; fiber-optic sensors
James D. Idol, *Professor of Ceramics/Packaging Science and Engineering, SE; Ph.D., Purdue*
  Permeation characteristics and physical properties of barrier packaging materials; catalytic processes, especially oxidation
Bernard H. Kear, *New Jersey Professor of Materials Science and Technology, SE; D.Sc., Birmingham*
  Synthesis, characterization, and properties of nanomaterials; high-pressure processing; flame-sprayed nanocoatings
Armen G. Khachaturyan, *New Jersey Professor of Materials Science and Technology, SE; Ph.D., Kiev Institute*
  Theory of phase transformation in metal alloys and ceramics; computer simulation of microstructure evolution
Lisa C. Klein, *Professor of Ceramic and Materials Engineering, SE; Ph.D., Massachusetts Institute of Technology*
  Sol-gel processing of coatings and monoliths; silicate and phosphate glasses; viscosity and transformation kinetics
Richard L. Lehman, *Professor of Ceramic and Materials Engineering, SE; Ph.D., Rutgers*
  Glass property/composition relationships; raw materials and processing

Jing Li, *Associate Professor of Chemistry, FAS–NB; Ph.D., Cornell*
  Synthesis and characterization of inorganic solid compounds
Yicheng Lu, *Professor of Electrical and Computer Engineering, SE; Ph.D., Colorado*
  Solid-state electronics
Adrian Mann, *Assistant Professor of Ceramic and Materials Engineering, SE; Ph.D., Oxford*
  Biomaterials; atomic force microscopy
M. John Matthewson, *Professor of Ceramic and Materials Engineering, SE; Ph.D., Cambridge*
  Mechanical properties of optical materials
William Mayo, *Professor of Ceramic and Materials Engineering, SE; Ph.D., Rutgers*
  High-pressure processing; nanomaterials; X-ray analysis
Ronald A. McCauley, *Professor of Ceramic and Materials Engineering, SE; Ph.D., Pennsylvania State*
  Corrosion of ceramics; phase equilibria; thermal analysis methods; luminescence; crystal chemistry; microscopy
Dale E. Niesz, *Professor and Director of the Malcolm G. McLaren Center for Ceramic Research, SE; Ph.D., Ohio State*
  Powder processing; sintering and fabrication; materials thermodynamics
Richard E. Riman, *Professor of Ceramic and Materials Engineering, SE; Ph.D., Massachusetts Institute of Technology*
  Hydrothermal synthesis; mixedness-modulated solid-state synthesis; reactive atmosphere sol-gel synthesis
Ahmad Safari, *Professor of Ceramic and Materials Engineering, SE; Ph.D., Pennsylvania State*
  Preparation, characterization of electroceramic materials for dielectric, piezoelectric, and ferroelectric applications; ferroelectric and superconductor ceramics and thin films
Alvin Salkind, *Professor of Biomedical Engineering, SE; D.Ch.E.; Polytechnic Institute of New York*
  Electrochemical systems; batteries
Daniel J. Shanefield, *Professor Emeritus of Ceramic and Materials Engineering, SE; Ph.D., Rutgers*
  Ceramic packaging for electronics; thin film electronics; organic chemical additives for ceramic processing
George H. Sigel, Jr., *Professor of Ceramic and Materials Engineering, SE; Ph.D., Georgetown*
  Optical materials; infrared transmitting materials; radiation resistant materials; optical sensors
Thomas Tsakalakos, *Professor of Ceramic and Materials Engineering, SE; Ph.D., Northwestern*
  Physical metallurgy; modulated structure materials; multilayered thin-film technology
John T. Wenzel, *Professor of Ceramic and Materials Engineering, SE; Ph.D., Chicago*
  Laser glasses; fiberization; sol-gel glasses
John Xu, *Assistant Professor of Ceramic and Materials Engineering, SE; Ph.D., Pennsylvania*
  Electrochemical materials

Adjunct Member of the Graduate Faculty

John J. Friel, *Ph.D., Pennsylvania*
  Sterology; structure property relationships; image analysis; X-ray analysis

Programs

Students may pursue M.S. and Ph.D. degrees in ceramic and materials science. In this option, the thesis work emphasizes the fundamental aspects of material behavior. Alternatively, students can arrange M.S. and Ph.D. programs in ceramic and materials engineering. Here, the thesis focuses on engineering and developmental aspects of materials. Students with full-time jobs in industry can arrange master's degree programs without a thesis, emphasizing manufacturing. The curriculum includes business- and industrial-engineering courses.

  Areas of specialization in ceramics include the following: fiber optics; structure and properties of glass; relation of microstructure and properties of ceramic materials; sintering mechanisms; rheology of slips; slip casting; preparation and properties of ceramic powders; dielectric materials, including ferroelectric, piezoelectric, and ferromagnetic ceramics; sol-gel processing; thin films; high-temperature materials; strength, toughening, and impact resistance; ceramic-metal systems and composites; nanotechnology; and biomaterials.

  The facilities of the program include approximately 25,000 square feet of well-equipped laboratories. Students will have access to a field-emission scanning electron microscope; a high-resolution TEM Raman microprobe; FITR; a Thermoanalyzer;

induction-coupled plasma (ICPunit); X-ray diffraction equipment; X-ray photoelectron spectroscopy equipment; a hot isostatic press; a pressure caster; mechanical testing machines; and SEMs.

The focus of much of the research is on the science and technology of synthesizing advanced ceramic materials. Processing ceramics from powders includes synthesis and characterization of powders, green forming (slip casting, tape casting, rapid prototype methods, injection molding, and spray drying/powder compaction), and densification of powder preforms (sintering, hot pressing, hot isostatic pressing, and preceramic polymer pyrolysis). In addition, ceramics are synthesized directly from sol-gels and used for coatings, filters, and battery components. Ceramics may be characterized mechanically, electrically, and thermally. Students will study surfaces using scanning tunneling microscopes and atomic force microscopes and by employing computer simulations using molecular dynamics. Ceramic composites are being studied to develop stronger, tougher ceramics. Ceramics with nanocrystalline microstructures are being studied. Dielectric, ferroelectric, piezoelectric, and other active/functional materials are being developed for electronic substrates, capacitors, actuators, sensors, and smart/intelligent materials.

Graduate assistantships and fellowships are available for both first-year and advanced graduate students. Generally, all full-time doctoral students receive financial support and tuition remission. Support usually is associated with sponsoring grants or contracts. Further information may be found on the program web site.

A prospective Ph.D. candidate must spend a minimum of one academic year in residence as a full-time student taking courses or pursuing research.

Academic and research training in packaging science and engineering is available in this program. For further information, see the packaging science and engineering courses and program description in this section under Packaging Science and Engineering.

Graduate Courses

16:150:501. (F) ADVANCED POWDER PROCESSING I (3)
Riman. Prerequisite: 16:150:531.
Examination and comparison of classical and high-technology, ceramic-processing systems using chemical thermodynamics and kinetics; understanding the approaches for chemically synthesizing ceramic material, coprecipitation, sol-gel processing, hydrothermal synthesis, plasma, and CVD.

16:150:502. (F) ADVANCED POWDER PROCESSING II (3)
Danforth
Microstructure development: powder; consolidation behavior; and sintering process, including thermodynamics compared with kinetics, and solid state compared with liquid phase or reactive densification.

16:150:503. (F) THEORY OF SOLID-STATE MATERIALS (3)
Khachaturyan
Basic principles of classical and quantum mechanics, as well as the experimental basis for introduction of quantum postulates. Application of these concepts to various physical phenomena to develop an understanding of solid-state material behavior.

16:150:504. (F) STRUCTURAL DEFECTS IN SOLIDS (3)
Cosandey. Prerequisite: 16:150:551 or equivalent.
Atomistic aspects of defects in solids, including point defects, dislocations, and grain boundaries; nature of partial dislocations; grain boundary dislocation interactions; grain boundary migration and segregation phenomena; nature of interfaces.

16:150:505. (F) ADVANCED GLASS I (3)
Wenzel
Advanced topics in glass science and engineering. Major emphasis on the structure and transport properties of oxide and selected nonoxide glasses. Detailed discussion of glass structure, structural modeling, and the relationship between structure and properties.

16:150:506. (S) ADVANCED GLASS II (3)
Sigel
Correlation of the fundamental optical properties of glasses to their structure and bonding. Intrinsic absorption and scattering, color, luminescence, photochromism, laser action, and nonlinear effects in glasses.

16:150:508. ADVANCED CERAMIC-METAL SYSTEMS (3)
Greenhut
Physical and chemical principles of interactions between metals and ceramic materials. Solid, liquid, and interfacial energies. The effect of microstructure in cermet bodies and its relationship to the exhibited properties. Practical systems such as oxide base cermets, carbides, and composite materials.

16:150:509. (F) ADVANCED ELECTRONIC CERAMICS (3)
Safari. Prerequisite: 14:154:421.
Electrical, optical, and magnetic properties of ceramic materials based on their electronic structure, defect chemistry, and transport processes.

16:150:510. (S) PHYSICAL PROPERTIES OF CRYSTALS (3)
Safari
Physical properties of crystals in tensor notation. What tensors are and how they are used. Common mathematical basis of tensor properties; thermodynamic relations among them.

16:150:511. THERMAL ANALYSIS OF CERAMIC MATERIALS (3)
McCauley. Course offered in alternate years.
Description of equipment used for differential thermal analysis (DTA), differential scanning calorimetry (DSC), and thermal gravimetric analysis (TGA). Calibration techniques. Interpretation of results. Relationships among sample thermal properties, particle size, sample size, crucible materials, heating rates, and atmospheres.

16:150:512. (S) ADVANCED CERAMIC MICROSCOPY (3)
McCauley. Prerequisite: 14:150:407.
Use of optical microscopy for the study of ceramic microstructures. Advanced techniques, including image analysis for studying both polished sections and thin sections. Techniques in photomicroscopy with application to a particular problem of interest to each student.

16:150:513. (F) MECHANICAL BEHAVIOR OF CERAMIC MATERIALS I (3)
Cannon
Mechanical behavior and properties of oxide and nonoxide ceramics, emphasizing fracture, microstructure, and environment. Differences in plastic behavior of ceramics related to creep, wear resistance, and hardness.

16:150:514. (S) MECHANICAL BEHAVIOR OF CERAMIC MATERIALS II (3)
Matthewson. Prerequisite: 16:150:513.
In-depth usage of advanced topics concerned with mechanical properties of ceramic materials, including thin films, fibers, and stress effects on properties.

16:150:515. (F) PROPERTIES OF OPTICAL CERAMICS (3)
Harrington. Prerequisites: 16:150:505, 506.
Waveguide propagation starting with Maxwell's equations, slab and cylindrical waveguides, active waveguides, fiber laser materials and configurations, infrared fiber waveguides, optical power delivery, fiber optic sensors.

16:150:516. (S) MOLECULAR BEHAVIOR OF GLASSES (3)
Prerequisites: Glass engineering or equivalent and 16:150:505, 506.
Atomic structure and properties of noncrystalline solids. Molecular mechanisms of macroscopic behavior. Topics include nature of the glass transition, structure/composition relations in oxide glasses, diffusion, and glass surfaces and interfaces.

16:150:517. (F) ADVANCED REFRACTORIES (3)
McCauley
Role of the phase equilibria and microstructure in the corrosion of refractories. Stability and behavior in selected environments, including ferrous and nonferrous metals, glass, and advanced energy systems.

16:150:520. (S) X-RAY AND SPECTROGRAPHIC METHODS IN CERAMICS (3)
Greenhut, Mayo
Principles, operation, and application: X-ray diffraction, X-ray fluorescence, analytical electron microscopy, microprobe analysis, high-temperature X-ray image and backscatter electron analysis, qualitative diffraction, and quantitative chemical and phase analysis.

16:150:521. (S) X-RAY AND SPECTROSCOPIC METHODS LABORATORY (1)
Greenhut, Mayo. Corequisite: 16:150:520.
Qualitative and quantitative chemical and phase analysis by X-ray fluorescence and diffraction methods, automated diffractometry, microanalysis and image analysis, strain and particle size determination, and sample preparation techniques, including random sampling.

16:150:522. (F) SCANNING ELECTRON MICROSCOPY AND X-RAY MICROANALYSIS (3)
Greenhut
Principles, operation, and application of scanning electron microscopy and X-ray microanalysis: electron optics; instrumental and signal resolution; qualitative and quantitative chemical microanalysis; image processing; signal and metallic samples for ceramic, organic, and metallic samples.

16:150:523. (F) SCANNING ELECTRON MICROSCOPY AND X-RAY MICROANALYSIS LABORATORY (1)
Greenhut. Corequisite: 16:150:522.
Operation of the scanning electron microscope: secondary, backscatter, and specimen current images; elemental distribution by line scans and mapping and quantation by X-ray fluorescence; electronic-image enhancement; stereoscopy; preparation of inorganic and organic samples.

16:150:524. (F) ADVANCED CERAMIC CHARACTERIZATION (3)
Cosandey. Prerequisites: 14:150:309, 359.
Instrumental techniques for characterization of ceramics and the study of processing and properties, including absorption and emission spectroscopy, FTIR and Raman spectroscopy, secondary ion mass spectrometry, XPS scanning Auger microscopy, neutron scattering.

16:150:525. (F) PROPERTIES OF CERAMIC SURFACES (3)
Garofalini
Surface structure of ceramic materials, absorption, surface diffusion, thin films.

16:150:526. (S) CRYSTAL CHEMISTRY OF CERAMIC MATERIALS (3)
McCauley
Relationship of structure to composition, temperature, and pressure. Importance of ionic radii, charge, and polarizability in determining structure. Study of families of compounds, compound formation, and phase transitions.

16:150:527. (F) THERMODYNAMICS OF CERAMIC SYSTEMS (3)
Matthewson
Emphasis on special thermodynamic considerations for ceramics: chemical thermodynamics; solution thermodynamics; and thermodynamics related to phase diagrams, surfaces, and point defects.

16:150:528. (F) MODERN ELECTROCHEMISTRY AND ELECTROCHEMICAL MATERIALS SCIENCE (3)
Xu
Electrochemistry and electrochemical materials science of advanced batteries, fuel cells, and sensors for industrial, environmental, and biomedical applications. Electrochemical methods and techniques.

16:150:529. (S) INTRODUCTION TO THE FUNDAMENTALS OF APPLIED COLLOID AND SURFACE CHEMISTRY (3)
Riman
Colloid or surface chemistry in solvent-based systems; characterization of colloid systems using direct and indirect methods. Thermodynamic treatments of surfaces, adsorption, and charged interfaces. Structural models incorporating neutral and charged adsorbates; various means of stabilizing and destabilizing colloids.

16:150:532. (S) KINETICS OF MATERIALS SYSTEMS (3)
Klein. Prerequisite: Differential equations.
Diffusion in solids. Solutions to Fick's first and second laws under important boundary conditions. Ionic diffusion. Diffusion applied to sintering. Solid-state reaction kinetics. Nucleation, crystal growth, and precipitation.

16:150:551. (F) PHYSICAL METALLURGY (3)
Tsakalakos
Crystal structure of metals and nature of bonding; free energy and phase diagrams; defect structure and relationship to mechanical properties; phase transformations and hardening mechanisms; recovery and recrystallization processes.

16:150:552. (S) PHASE TRANSFORMATIONS IN METAL AND ALLOYS (3)
Prerequisite: 16:150:551 or equivalent.
Thermodynamics and phase diagrams. Solid solutions. Ordered phases. Coherent, semicoherent, and incoherent precipitates. Diffusion-controlled and interface-controlled growth. Nucleation and growth theories. Overall transformation kinetics. Precipitation. Diffusionless transformations.

16:150:553. (F) MECHANICAL BEHAVIOR OF METALS (3)
Mayo. Prerequisite: 16:150:551.
Response of metals to applied forces from both macroscopic and microscopic points of view. Crystal defect structures as they relate to plastic flow and the onset of fracture. Case studies of metal deformation and fracture, including fatigue, creep, environmentally assisted fracture, and wear.

16:150:561. (F) MATERIALS SCIENCE LABORATORY (3)
Mayo. Prerequisite: Previous computer experience.
Use of instrumentation in the modern analysis laboratory, such as X-ray diffractometers, creep machines, torsional pendulum. Computer-controlled data acquisition, noise reduction, and curve fitting methods.

16:150:563. (F) ELEMENTARY X-RAY DIFFRACTION (4)
Principles of atomic arrangements; X-ray diffraction by real crystals and elucidation of structure-sensitive properties; identification of unknown substances, phase analysis, X-ray topographic methods, and special methods to characterize defect structures of materials.

16:150:564. (S) ADVANCED DIFFRACTION ANALYSIS (3)
Prerequisite: 16:150:563.
Application of Fourier transform and convolution methods to diffraction of amorphous and crystalline materials; elucidation of lattice defects and correlation to properties of materials, dynamical theory, and application in materials science.

16:150:566. (S) ELECTRON MICROSCOPY (3)
Cosandey
Nature of the electron microscope; techniques of specimen preparation; theory of electron diffraction; diffraction patterns; application to crystal structure; crystal morphology and defects in various engineering materials.

16:150:567. (S) ELECTRON MICROSCOPY LABORATORY (1)
Techniques of electron microscopy and application to structure and defect structure of materials.

16:150:568. (F) Advanced Electron Microscopy (3)
Cosandey. Prerequisites: 16:150:566, 567, or equivalent.
Principles and aspects of dynamical theory. Weak-beam analysis. High-resolution imaging. Convergent-beam diffraction. Scanning transmission and analytical microscopy. Description and application of specialized microscopy techniques to materials problems, including metals, ceramics, and polymers.

16:150:569. (F) Quantitative Metallography (3)
Tsakalakos
Theory and practice of stereological aspects of quantitative analysis of microstructures observed in alloy, ceramic, polymeric, histological, and other materials. Determination of three-dimensional properties of microstructures by means of measurements of two-dimensional sections, transmission, or scanning electron micrographs.

16:150:571,572. Introduction to Packaging Engineering I,II (3,3)
Materials science, engineering, design, development and testing, packaging machinery, package production, distribution, marketing and resource utilization.

16:150:575. (F) Packaging—Regulatory Aspects (3)
Prerequisites: 16:150:571,572.
State and federal regulation of packaging and labeling for consumer and environmental protection. Regulations for engineers and scientists to design and fabricate legal containers. Forecasting and aiding in development of future trends in regulatory action.

16:150:576. (S) Packaging Machinery (3)
Prerequisites: 16:150:571,572.
Interrelationship between machinery and materials; package-production lines; principles of machine design and selection and economics of choice of alternatives.

16:150:577,578. Materials and Design in Packaging (3,3)
Idol. Prerequisites: 16:150:571,572.
Package design problems from point of view of chemical, physical, and engineering behavior of entire system. Emphasis on properties of packaging materials and relation of those properties to structure and performance.

16:150:581,582. Seminar in Packaging (1,2)
Idol. Prerequisites: 16:150:571,572.

16:150:583,584. Materials and Package Evaluation Laboratory (3,3)
Lec. 1 hr., lab. 6 hrs. Prerequisites: 16:150:571,572.
Principles and practices used in the characterization and evaluation of the engineering properties of packaging materials and packages. Gas and vapor permeation of materials and packages; physical properties of materials and packages; package dynamics.

16:150:587,588. Special Problems in Packaging (BA,BA)
Idol. Prerequisites: 16:150:571,572, and permission of instructor.

16:150:595. Structural Transformations in Solids I (3)
Tsakalakos. Prerequisites: 16:150:551, 552.
Crystallography of phase transformations. Stability of homogeneous solutions. Static concentration wave theory. Decomposition in alloys. Spinodal decomposition. Elastic coherency strain. Morphology of single coherent inclusions. Applications: precipitation, ceramics, polymer blends.

16:150:596. Advanced Topics in Materials (3)
Khachaturyan. Pre- or corequisites: 16:150:551, 552 or equivalent.
Diffusional transformations in crystalline materials. Ordering. Symmetry and long-range order. Symmetry and thermodynamics. Nonstoichiometry and ordering in ceramic systems. Decomposition in ceramic and metal systems. Diffusional kinetics. Elementary atomic processes in diffusion. Diffusionless (displacive) transformations. Crystallography of crystal lattice rearrangement. Crystal lattice coherency. Habit plane and orientation relationships.

Orientation relations. Shape Memory Effect. Ferroelectric and ferroelastic transitions. Striction. Transformation-induced strain and strain-accommodating structures. Applications to ferroelectric and ferroelastic systems and to metal alloys.

16:150:597,598. (F,S) Case Studies in Manufacturing Ceramics (3,3)
Niesz
Students work in groups to research problems and present reports. Students solve an actual industrial manufacturing problem in collaboration with a local industrial company.

16:150:601,602. Ceramics and Materials Seminar (1,1)
Cannon
Current areas of research studied and discussed.

16:150:603,604. (F,S) Special Problems in Ceramics and Materials Science (BA,BA)

16:150:701,702. Research in Ceramics and Materials (BA,BA)

CHEMICAL AND BIOCHEMICAL ENGINEERING 155

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Yee Chiew, Engineering Building C105B, Busch Campus (732/445-0315)**

Members of the Graduate Faculty

Fred R. Bernath, *Associate Professor of Chemical and Biochemical Engineering, SE; Ph.D., Rutgers*
Biomedical engineering; transport phenomena
Helen M. Buettner, *Associate Professor of Chemical and Biochemical Engineering, SE; Ph.D., Pennsylvania*
Neurobiology; cell motility; biomedical engineering
Yee C. Chiew, *Professor of Chemical and Biochemical Engineering, SE; Ph.D., Pennsylvania*
Complex fluids, thermodynamics, molecular simulations, interfacial phenomena
Alkis Constantinides, *Chair and Professor of Chemical and Biochemical Engineering, SE; D.E.Sc., Columbia*
Biochemical engineering; modeling of fermentation processes
Peter R. Couchman, *Professor of Chemical and Biochemical Engineering, SE; Ph.D., Virginia*
Polymer theory, behavior of miscible systems, thermodynamics, polymers at interfaces
Alberto M. Cuitiño, *Associate Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Brown*
Powder mechanics; micromechanics; computer methods
Burton Davidson, *Professor of Chemical and Biochemical Engineering, SE; Ph.D., Northwestern*
Alternate fuels; control theory; safety systems engineering
Panagiotis G. Georgopoulos, *Associate Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., California Institute of Technology*
Environmental chemical engineering; turbulent transport; reactive flows
Benjamin J. Glasser, *Associate Professor of Chemical and Biochemical Engineering, SE; Ph.D., Princeton*
Multiphase flows and reactors; granular materials and particulate suspensions; nonlinear dynamics of transport processes
Masanori Hara, *Professor of Chemical and Biochemical Engineering, SE; Ph.D., Kyoto*
Polymer physics; structure-property relationships of ion-containing polymers in solid and solution
Marianthi G. Ierapetritou, *Assistant Professor of Chemical and Biochemical Engineering, SE; Ph.D., Imperial College*
Process systems engineering; process design, planning, and scheduling; uncertainty and environmental considerations; nonlinear and mixed integer optimization
Johannes G. Khinast, *Assistant Professor of Chemical and Biochemical Engineering, SE; Ph.D., Graz*
Reaction and environmental engineering; reactive flows; numerical analysis of large dynamical systems
Michael T. Klein, *Dean and Board of Governors Professor of Engineering, SE; Sc.D., Massachusetts Institute of Technology*
Kinetics, catalysis, and reaction engineering; automated kinetic modeling; hydrocarbon conversion; reactions in supercritical fluids

Joachim B. Kohn, *Professor of Chemistry, FAS–NB; Ph.D., Weizmann Institute of Science*
Biotechnology; bioorganic chemistry; new methods for drug delivery

Prabhas V. Moghe, *Associate Professor of Chemical and Biochemical Engineering, SE; Ph.D., Minnesota*
Bioengineering and microarchitecture of polymeric tissue analogs; cell-biomaterial interactions; tissue engineering of liver, skin, and blood vessels; fluid flow and "cellular stress engineering"; quantitative 3-D reconstructive confocal microscopy

Gaetano T. Montelione, *Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Cornell*
Nuclear magnetic resonance studies of proteins; protein molecular design; mecha - nisms of protein folding

Fernando Muzzio, *Professor of Chemical and Biochemical Engineering, SE; Ph.D., Massachusetts (Amherst)*
Mixing; chaos and randomness; transport phenomena

Henrik Pedersen, *Professor of Chemical and Biochemical Engineering, SE; Ph.D., Yale*
Biochemical engineering; reactor design; plant cell culture

Richard E. Riman, *Professor of Ceramic Science and Engineering, SE; Ph.D., Massachusetts Institute of Technology*
Hydrothermal synthesis, microencapsulation, solid-state synthesis, mixedness, reactive sol-gel halide synthesis, solution thermodynamics, crystalliza - tion, granulation

Charles M. Roth, *Assistant Professor of Chemical and Biochemical Engineering, SE; Ph.D., Delaware*
Molecular bioengineering; gene-based technologies; cell systems engineering

Alvin J. Salkind, *Professor of Surgery, UMDNJ–RWJMS; D.Ch.E., Polytechnic Institute of New York*
Electrochemical engineering; energy; metal recovery

Jerry I. Scheinbeim, *Professor of Chemical and Biochemical Engineering, SE; Ph.D., Pittsburgh*
Polymer electroprocessing, structure-electroactive properties relationships in elec - troactive polymeric materials; ferroelectric, peizoelectric, pyroelectric, dielectric, and electrostrictive properties of polymers

Troy Shinbrot, *Assistant Research Professor of Chemical and Biochemical Engineering, SE; Ph.D., Maryland*
Nonlinear dynamics, mixing, control, and granular flow

Silvina Tomassone, *Assistant Professor of Chemical and Biochemical Engineering, SE; Ph.D., Northeastern*
Molecular dynamics of chain surfactants at the air/water interface

Kathryn E. Uhrich, *Assistant Professor of Chemistry, FAS–NB/SE; Ph.D., Cornell*
Polymer design, synthesis, and characterization; microlithography

Shaw S. Wang, *Professor of Chemical and Biochemical Engineering, SE; Ph.D., Rutgers*
Biochemical engineering; food science and technology

Martin L. Yarmush, *Visiting Professor of Chemical and Biochemical Engineering, SE; Ph.D., Rockefeller*
Applied immunology; bioseparations; artificial organs and tissue engineering

Associate Members of the Graduate Faculty

William Craelius, *Associate Professor of Biomedical Engineering, SE; Ph.D., Northwestern*
Cardiac and neural electrophysiology

Carlos B. Rosas, *Distinguished Visiting Professor and Administrative Director, Pharmaceutical Engineering Program; M.E., Stevens*
Fine chemicals, pharmaceuticals, and biologicals

K. Venkatasubramanian, *Visiting Professor of Chemical and Biochemical Engineering, SE; Ph.D., Rutgers*
Applied molecular biology; biochemical process economics

Adjunct Member of the Graduate Faculty

Rolf R. Arands, *Assistant Research Professor of Chemical and Biochemical Engineering, SE; Ph.D., Rutgers*
Molecular simulations and modeling of contaminant behavior in soil systems

Programs

The graduate program in chemical and biochemical engineering has three major elements: engineering science, applied chemistry, and biochemical engineering. Engineering science includes the transport processes, with an emphasis on mass transfer, thermodynamics, and applied mathematics. Applied chemistry encompasses surface chemistry, applied chemical kinetics, catalysis, synthesis, and prop- erties of polymers, semipermeable membranes, and electrochem- istry. Biochemical engineering deals with microbial and enzyme technology, fermentations, applied biochemical kinetics and cataly- sis, biological separations, and applied molecular biology.

The program combines academic instruction with practical appli- cation by stressing student projects. It encourages students to be creative and to show originality in applying basic and advanced chemical and biochemical engineering principles to solve research

and design problems. Program participants develop practical appli- cations for industrial processing and for improving environmental quality. At the same time, they gain a better understanding of chem- ical and biochemical reactions. Research efforts focus on advancing basic scientific theories and developing useful applications.

Master's degree candidates may elect a thesis or nonthesis option. The thesis option consists of a minimum of 30 credits— 24 course credits and 6 credits for a thesis on a research or design problem. In the nonthesis option, a candidate must complete 30 course credits and submit a critical essay. The nonthesis option is suited to the student who has extensive research experience or full-time professional responsibilities in industry. The program for the Ph.D. normally consists of a minimum of 30 credits of course work and 24 to 42 credits of research beyond the B.S. degree. The total number of credits required is 72. The course work for the Ph.D. and M.S. degrees includes the following core courses: chemical engineering analysis; advanced transport phenomena I and II; advanced chemical engineering thermodynamics; and kinetics, catalysis, and reactor design. The master of philosophy degree is available to doctoral candidates. The doctoral qualifying examination, given each year, stresses fundamentals of chemical engineering and advancements in the profession as reflected in the current graduate instructional program.

Before they complete the program, all students must give an oral presentation on their research or area of interest. There is no language or residency requirement.

Faculty and students in the program are involved in a broad range of research areas. Research in biochemical engineering includes such topics as enzyme and microbial engineering, bio- membrane transport theory, plant and insect cell culture, imaging and biosensing, mammalian cell culture, and biomedical engineer- ing. Chemical environmental efforts involve the use of basic chemical engineering principles such as mass, momentum, and energy balances; reactor theory; and system simulation to solve problems of surface water and groundwater quality; advanced biological and physiochemical treatment systems; solid-waste management; incineration; and hazardous substance evaluation and disposal. Pharmaceutical engineering research focuses on such topics as solids mixing, granular materials and particulate suspen- sions, powder processing, and crystallization. Alternate fuels research includes enhanced alcohol fermentation and electrochemi- cal engineering, with an emphasis on battery failure analysis. Liquid-liquid extraction, supercritical extraction processes, and flow simulation in mixing processes are examples of mass transfer applications. Work in statistical thermodynamics is an option.

Graduate assistantships and fellowships are available for both first-year and advanced graduate students. Students participating in the research program on a sponsored basis receive a stipend for either a 10-month or a 12-month period and have their tuition remitted. Support usually is associated with sponsoring grants or contracts, and specific information on available projects is provided by the graduate director. It is common for an exchange of information on assistantships or fellowships to occur during consideration of admission when program officials try to identify students' interests.

Graduate Courses

16:155:501. (F) ADVANCED TRANSPORT PHENOMENA I (3)
Prerequisite: Undergraduate transport phenomena.
Momentum transport processes in laminar- and turbulent-flow systems. Development and application of steady and unsteady boundary-layer processes, including growth, similitude principles, and separation. Potential flow theory coupled with viscous dissipa- tion at boundaries. Momentum transport in fixed- and fluid-bed exchangers and reactors.

16:155:502. (S) ADVANCED TRANSPORT PHENOMENA II (3)
Prerequisite: Permission of instructor.
Energy balances derived from first and second law approaches to open systems, with reaction. Conduction in fluids and solids, both steady and unsteady examples. Convection in laminar- and turbulent-flow systems. Diffusion and its treatment in stagnant and flowing media. Two-phase systems, coupled reaction, and mass transfer. Interphase transport.

16:155:503. (F) ADVANCED TRANSPORT PHENOMENA III (3)
Pre- or corequisites: 16:155:501, 502.
Advanced topics in momentum, heat, and mass transfer. Special emphasis on computational techniques.

16:155:504. (S) MIXING: THEORY AND APPLICATIONS (3)
Prerequisite: Undergraduate fluid mechanics.
Theory of mixing processes in laminar and turbulent flows. Practical aspects of mixing processes (equipment selection, design, scale-up) used in industrial operations.

16:155:506. FLUID PARTICLES AND GRANULAR FLOW (3)
Flow of granular materials and fluid-particle suspensions. Continuum and discrete modeling, process equipment. Applications in the chemical and pharmaceutical industries addressing hydrodynamics, mixing, segregation, granulation, and reactive multiphase flows.

16:155:507. (F) ANALYTICAL METHODS IN CHEMICAL AND BIOCHEMICAL ENGINEERING (3)
Prerequisites: Undergraduate differential and integral calculus and differential equations or permission of the graduate director.
Analytical solutions to deterministic mathematical models encountered in chemical and biochemical engineering, including environmental and safety systems. Emphasis is on purpose, philosophy, classification, development, and analytical solutions of models occurring in transport phenomena, thermochemical, and reactor systems.

16:155:508. (F) CHEMICAL ENGINEERING ANALYSIS (3)
Prerequisite: Undergraduate or graduate degree in chemical engineering or in the biological or physical sciences.
Mathematical modeling and simulation of chemical and biochemical systems; numerical methods. Solution of ordinary and partial differential equations. Statistical methods of linear and nonlinear regression analysis; optimization methods. Extensive use of digital computers.

16:155:509. NONLINEAR DYNAMICS AND CHAOS (3)
Nonlinearities in practical systems: time series analysis; delay space embedding; real-time control of experimental chaotic systems; significance and treatment of node coupling in linear problems; and meaning and analysis of Lyapunov exponents.

16:155:511. (F) ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS (3)
Prerequisite: Undergraduate or graduate degree in engineering or chemistry.
Basic principles of classical chemical thermodynamics. Chemical and physical equilibria and their relationships in simple and reactive systems. Estimation and correlation of thermodynamic functions, applications of thermodynamic principles to transport and rate processes. Irreversible and statistical thermodynamic topics also introduced.

16:155:512. ADVANCED CHEMICAL ENGINEERING MOLECULAR THERMODYNAMICS (3)
Prerequisite: 16:155:511 or equivalent.
Statistical ensembles; ideal and nonideal gases; liquids; distribution function theories; Ornstein-Zernike equation; computer simulation methods; perturbation theories; engineering semiempirical equations of state; applications to chemical engineering systems.

16:155:514. (S) KINETICS, CATALYSIS, AND REACTOR DESIGN (3)
Prerequisites: 16:155:501 and 507, or equivalent.
Principles of applied chemical kinetics, reaction mechanisms and rate laws, and engineering design of reactor vessels. Applications to homogeneous and heterogeneous process reaction systems with internal, transphase, and external mass transfer. Noncatalytic gas-solid reaction and gas-liquid absorption with reaction. Micromixing and macromixing in reactor systems.

16:155:517. ADVANCED PROCESS CONTROL (3)
Prerequisite: Process control or permission of instructor.
Review of analysis and design of feedback control systems. Advanced process control systems. Control systems for multivariable processes. Process control systems, using computers and artificial intelligence techniques. Intelligent control laboratory.

16:155:518. (S) PROCESS SYSTEMS ENGINEERING (3)
Prerequisite: Undergraduate engineering design.
Key issues in process synthesis and design and process operations. Mathematical modeling, algorithmic development and optimization. Computer-aided tools. Applications: planning and scheduling of batch/continuous processes, energy integration in industrial plants, uncertainty evaluation and consideration in plant design. Case studies.

16:155:531. (F) BIOCHEMICAL ENGINEERING (3)
Prerequisites: Degree or option in biochemical engineering, or 01 or 11:115:301 and 01:119:390, or equivalent.
Integration of the principles of chemical engineering, biochemistry, and microbiology. Development and application of biochemical engineering principles. Analysis of biochemical and microbial reactions.

16:155:532. (F) TOPICS IN BIOCHEMICAL ENGINEERING (3)
Prerequisite: 16:155:531.
Advanced course devoted to current topics of interest in biochemical and enzyme engineering. Topics include production, isolation, and purification of enzymes; downstream processing; design and analysis of bioreactors; bioprocess economics; modeling, optimization, and scale-up of biochemical systems. Content and format may vary from year to year.

16:155:533. (S) BIOSEPARATIONS (3)
Prerequisite: Permission of instructor.
Fundamental problems of separation processes important to the recovery of products from biological processes. Topics include membrane filtration centrifugation, chromatography, extraction, electrokinetic methods. Emphasis on protein separations.

16:155:534. (S) ENZYME ENGINEERING (3)
Prerequisite: Undergraduate or graduate degree in chemical or biochemical engineering or in the biological sciences.
Application of biochemical engineering principles to enzyme technology. Enzyme structure and function, biochemical and biophysical properties, enzyme stability, mathematical models for inactivation. Design and analysis of enzyme and fixed microbial cell reactors. Use of enzymes in industrial, environmental, and medical applications. Case studies of commercial enzyme processes.

16:155:542. CHEMICAL PROCESSING OF DRUGS AND FINE CHEMICALS (3)
Chemical process operations and engineering methods used in the development, scale-up, and manufacture of drugs and fine chemicals; design and regulatory compliance methods for batch multiproduct plants.

16:155:543. INDUSTRIAL CHEMISTRY OF DRUGS AND FINE CHEMICALS (3)
Chemical process development, scale-up, and regulatory environment of drugs and fine chemicals; strategies and technologies for the synthesis and semisynthesis of drugs. Transition from the bench to the FDA-approved plant.

16:155:548. ADVANCED TOPICS IN PHARMACEUTICAL ENGINEERING (3)
Thermochemical process safety; physiochemical methods at the bulk/dosage form interface; and surface chemistry of crystallization, extraction, and adsorption.

16:155:551. (F) POLYMER SCIENCE AND ENGINEERING I (3)
Physical and chemical structure of polymers; morphology of polymer crystals; microscopic texture. Mechanical properties; influence of orientation; effects of temperature and environment; engineering applications.

16:155:552. POLYMER SCIENCE AND ENGINEERING II (3)
Prerequisite: 16:155:551.
Emphasis on a modern treatment of polymers, including statistical mechanics scaling concepts and polymer properties and characterization.

16:155:553. POLYMER SCIENCE AND ENGINEERING LABORATORY (1)
Pre- or corequisite: 16:155:551.
Basic structure-property relationships of polymeric materials in their liquid, glassy, and crystalline states, including synthesis, molecular weight distribution, morphology, and thermal and mechanical properties.

16:155:554. POLYMER PROCESSING (3)
Prerequisites: 16:155:551, 552.
Extrusion, transfer, and compression molding; injection molding, thermoforming, and blow molding; thermoset, thermoplastics, and elastomers. Additives and fillers, coatings, laminates, mold designs, heat sealing, and orientation in films and fibers.

16:155:555. POLYMER PHYSICS (3)
Prerequisites: 16:155:551, 552.
Introduction to physics of high polymers and their properties in the solid state; discussion of dielectric, mechanical, and nuclear magnetic resonance phenomena and application to relaxation behavior; theories of rubber elasticity and viscoelasticity; yield and fracture behavior.

16:155:556. POLYMER RHEOLOGY (3)
Prerequisites: 16:155:551, 552.
Introduction to viscosity and rheological phenomena in high polymers; the relation of these to molecular parameters and their applications in polymer physics, polymer engineering, and polymer processing.

16:155:557. ADVANCED POLYMER PHYSICS (3)
Prerequisites: 16:155:554, 555.
Theory of thermoelastic behavior of rubbers, calculations of surface tension for single and multicomponent systems, Gibbs-DiMarzio theory of glass transitions, effect of pressure on transitions, relaxations, viscoelastic behavior of homopolymer blends, diffusion, viscosity.

16:155:558. VIBRATIONAL SPECTROSCOPY OF POLYMERS (3)
Prerequisites: 16:155:551, 552.
Physical basis for infrared absorption and Raman scattering. Theory of molecular vibrations. Michelson interferometer with associated optical and computational techniques. Modeling of vibrational properties of chain molecules. Applications to synthetic and biological macromolecules.

16:155:559. SCATTERING METHODS IN POLYMER SCIENCE (3)
Prerequisites: 16:155:551, 552.
Basic scattering theory and its application in studying polymers in solution and solid state: static and dynamic light scattering, small-angle X-ray scattering, and small-angle neutron scattering.

16:155:561. APPLIED SURFACE CHEMISTRY (3)
Prerequisite: Undergraduate or graduate degree in chemical engineering or in the biological or physical sciences.
Phenomena and processes relevant to chemical engineering characterized by large interfacial area relative to phase volume. Fundamental principles of surface chemistry and physics, such as interfacial tension and pressure. Study of colloidal state and colloidal particles. Theories of electrical double layer and stability of suspensions. Application of theory to important processes such as foaming, emulsification, detergency, adhesion, ore flotation, and rate processes controlled at a phase interface, including nucleation and crystallization.

16:155:562. SYNTHESIS AND PROPERTIES OF SOLID POLYMERS (3)
Prerequisite: Undergraduate or graduate degree in chemical engineering or in the biological or physical sciences.
Advanced treatment of polymer processes and resultant polymer properties from the interrelated points of view of reaction engineering (including catalytic routes) and materials science (structure-property relationships) appropriate to the modern generation of engineering polymers.

16:155:563. (F) SEMIPERMEABLE MEMBRANES (3)
Prerequisite: Undergraduate or graduate degree in chemical engineering or in the biological or physical sciences.
Applied physiochemical principles that underlie the frontier applications of barrier diffusion.

16:155:572,573. ELECTROCHEMICAL ENGINEERING I,II (3,3)
Prerequisite: Undergraduate or graduate degree in chemical engineering or chemistry.
Introduction to the principles and applications of electrochemical engineering properties of electrodes. Electrochemical engineering, energy conversion, and storage thermodynamics and design features in primary and secondary fuel cells, and in metallic corrosion, electroforming, and electrolysis.

16:155:574. SOLVENT EXTRACTION ENGINEERING (3)
Prerequisite: Undergraduate or graduate degree in chemical engineering or chemistry.
Advanced treatment of solvent extraction operations, including both practical design approaches and a systematic development based on the fundamental aspects of mass transfer, mass transfer with reaction, and dispersion modeling in various contractor configurations.

16:155:575. ELECTROCHEMICAL ENGINEERING TECHNIQUES (3)
Lec. 2 hrs., lab. 3 hrs. Prerequisites: 16:155:572,573.
Lecture-laboratory course providing theoretical and practical experience in techniques of studying charge-transfer and mass-transfer controlled reactions in corrosion, electroplating, battery energy conversion, the production of chemicals, and other electrochemical applications.

16:155:582. FUNDAMENTALS OF CONTAMINANT MASS TRANSFER (3)
Prerequisite: Undergraduate degree in chemical, biochemical, or environmental engineering, or permission of instructor.
Theory and mathematical modeling of thermodynamics, reaction, and diffusive and convective mass transfer for inorganic and organic contaminants in porous media, emphasizing behavior in sediments and saturated soils.

16:155:588,589. (F) SPECIAL PROBLEMS IN CHEMICAL ENVIRONMENTAL ENGINEERING (3,3)
Prerequisites: 16:155:501, 502, or equivalent.
Natural water bodies described by the techniques developed for chemical and biochemical reactor analysis. Physical transport, interfacial exchanges, and biochemical reactions. Examples drawn from reaeration processes, surface water temperature and energy balances, and stochastic variations in stream discharge.

16:155:601,602. CHEMICAL ENGINEERING GRADUATE SEMINAR (N1,N1)
Graduate students make a formal presentation on their independent study and/or research. Outside speakers also are invited.

16:155:603,604. TOPICS IN ADVANCED BIOTECHNOLOGY (1,1)
Prerequisite: Permission of instructor.
Oral presentations and discussions of current literature in biotechnology. Topics selected from the following: tissue, genetic, and protein engineering; growth control; receptor signaling; immunotechnology; neurotechnology; and others.

16:155:701,702. RESEARCH IN CHEMICAL AND BIOCHEMICAL ENGINEERING (BA,BA)

CHEMISTRY 160

Degree Programs Offered: **Master of Science, Master of Science for Teachers, Doctor of Philosophy**
Director of Graduate Program: **Professor Roger A. Jones, Wright-Rieman Laboratories, Busch Campus (732/445-3223)**
Vice Chairperson for Graduate Studies: **Professor Martha A. Cotter, Wright-Rieman Laboratories, Busch Campus (732/445-2259)**

Members of the Graduate Faculty

Stephen Anderson, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Harvard*
Alzheimer's disease, protein engineering, protein folding

Georgia A. Arbuckle-Keil, *Professor of Chemistry, FAS–C; Ph.D., Pennsylvania*
Synthesis/properties of conducting polymers; quartz crystal microbalance study of electroactive surfaces

Edward Arnold, *Professor of Chemistry, FAS–NB; Ph.D., Cornell*
Crystallographic studies of human viruses and viral proteins

Jean S. Baum, *Professor of Chemistry, FAS–NB; Ph.D., California (Berkeley)*
Structural studies of proteins by nuclear magnetic resonance techniques

Helen M. Berman, *Professor of Chemistry, FAS–NB; Ph.D., Pittsburgh*
Structural biology, structural nucleic acids, bioinformatics

Robert S. Boikess, *Professor of Chemistry, FAS–NB; Ph.D., Columbia*
Chemical education

John G. Brennan, *Professor of Chemistry, FAS–NB; Ph.D., California (Berkeley)*
Molecular and solid-state inorganic chemistry

Kenneth J. Breslauer, *Professor of Chemistry, FAS–NB; Ph.D., Yale*
Characterization of the molecular interactions that control biopolymer structure and stability

Kieron Burke, *Assistant Professor of Chemistry, FAS–NB; Ph.D., California (Santa Barbara)*
Density functional theory in quantum chemistry and solid-state physics

Edward Castner, Jr., *Associate Professor of Chemistry, FAS–NB; Ph.D., Chicago*
Ultrafast dynamics and photoreactions in solution

Yves J. Chabal., *Professor of Chemistry, FAS–NB; Ph.D., Cornell*
Surface and interface chemistry of electronic, photonic, and nano materials

Kuang-Yu Chen, *Professor of Chemistry, FAS–NB; Ph.D., Yale*
Biophysical and biological chemistry; polyamines in cancer and aging

Martha A. Cotter, *Professor of Chemistry, FAS–NB; Ph.D., Georgetown*
Theoretical investigations of liquid crystals and micellar systems

Richard H. Ebright, *Professor of Chemistry, WIM/FAS–NB; Ph.D., Harvard*
Protein-DNAinteraction; protein-protein interaction

Eric L. Garfunkel, *Professor of Chemistry, FAS–NB; Ph.D., California (Berkeley)*
Surface science; ultra thin films and interfaces for nanoelectronics growth; molecular adsorption on surfaces

Millie M. Georgiadis, *Assistant Professor of Chemistry, WIM/FAS–NB; Ph.D., California (Los Angeles)*
X-ray crystallographic studies of retroviral enzymes

Alan S. Goldman, *Professor of Chemistry, FAS–NB; Ph.D., Columbia*
Organometallic chemistry: homogeneous catalysis

Lionel Goodman, *Professor of Chemistry, FAS–NB; Ph.D., Iowa State*
Laser spectroscopy with emphasis on multiphoton excitation

Martha Greenblatt, *Professor of Chemistry, FAS–NB; Ph.D., Polytechnic Institute of New York*
Solid-state inorganic chemistry; low dimensional transition-metal oxides

Gene S. Hall, *Associate Professor of Chemistry, FAS–NB; Ph.D., Virginia Polytechnic Institute*
Biochemistry and function of polyamines and hypusine

Gregory F. Herzog, *Professor of Chemistry, FAS–NB; Ph.D., Columbia*
Origin and evolution of meteorites; cosmogenic radioisotopes

Jane Hinch, *Associate Professor of Chemistry, FAS–NB; Ph.D., Cambridge*
Molecular beam-surface interactions and diffractive techniques

Stephan S. Isied, *Professor of Chemistry, FAS–NB; Ph.D., Stanford*
Bioinorganic chemistry; long-range intramolecular electron transfer

Leslie S. Jimenez, *Associate Professor of Chemistry, FAS–NB; Ph.D., California (Los Angeles)*
Synthesis and characterization of analogs of antitumor antibiotics, total synthesis of natural products

Roger A. Jones, *Chairperson and Professor of Chemistry, FAS–NB; Ph.D., Alberta*
Nucleoside and nucleic acid synthesis

Spencer A. Knapp, *Professor of Chemistry, FAS–NB; Ph.D., Cornell*
Total synthesis of natural products; design and synthesis of enzyme models

Joachim B. Kohn, *Professor of Chemistry, FAS–NB; Ph.D., Weizmann Institute of Science*
Development of structurally new polymers as biomaterials for medical applications

John Krenos, *Associate Professor of Chemistry, FAS–NB; Ph.D., Yale*
Chemical physics, energy transfer in hyperthermal collisions

Karsten Krogh-Jespersen, *Professor of Chemistry, FAS–NB; Ph.D., New York*
Computational studies of molecular electronic structure; excited electronic states

Jeehiun Katherine Lee, *Associate Professor of Chemistry, FAS–NB; Ph.D., Harvard*
Experimental and theoretical studies of biological and organic reactivity

Ronald M. Levy, *Professor of Chemistry, FAS–NB; Ph.D., Harvard*
Biophysical chemistry; chemical physics; dynamics of macromolecules

Jing Li, *Associate Professor of Chemistry, FAS–C; Ph.D., Cornell*
Inorganic and materials chemistry, synthesis, structure characterization

Theodore E. Madey, *Professor of Physics and Chemistry, FAS–NB; Ph.D., Notre Dame*
Structure and reactivity of surfaces and ultrathin films

Gerald S. Manning, *Professor of Chemistry, FAS–NB; Ph.D., California (San Diego)*
Physics and physical chemistry of polymers, ionic, and elastic effects on biopolymer structure

Gaetano T. Montelione, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Cornell*
Structure and dynamics of protein-protein and protein-nucleic acid complexes

Robert A. Moss, *Professor of Chemistry, FAS–NB; Ph.D., Chicago*
Chemistry of reactive intermediates: carbenes, carbocations, diazirines

Wilma Olson, *Professor of Chemistry, FAS–NB; Ph.D., Stanford*
Theoretical and computational studies of nucleic acid structure and properties

Joseph A. Potenza, *University Professor of Chemistry, FAS–NB; Ph.D., Harvard*
Molecular structure; X-ray diffraction; magnetic resonance

Laurence Romsted, *Professor of Chemistry, FAS–NB; Ph.D., Indiana*
Micellar organic chemistry; organic reaction mechanisms

Heinz D. Roth, *Professor of Chemistry, FAS–NB; Ph.D., Cologne*
Electron transfer induced chemistry, physical organic chemistry of reactive intermediates

Harvey J. Schugar, *Professor of Chemistry, FAS–NB; Ph.D., Columbia*
Inorganic and bioinorganic chemistry, modeling of metalloprotein active sites

Stanley Stein, *Adjunct Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; Ph.D., CUNY*
Methods development in protein analysis

David Talaga, *Assistant Professor of Chemistry, FAS–NB; Ph.D., California (Los Angeles)*
Protein folding and conformational dynamics, single molecule studies

John W. Taylor, *Associate Professor of Chemistry, FAS–NB; Ph.D., Chicago*
Bioactive peptide design and synthesis, multicyclic peptides

Kathryn E. Uhrich, *Associate Professor of Chemistry, FAS–NB; Ph.D., Cornell*
Synthesis and characterization of novel polymers for drug delivery

Ralf Warmuth, *Associate Professor of Chemistry, FAS–NB; Ph.D., Frankfort*
Design and synthesis of conformationally constrained peptides and of ion channels

Lawrence J. Williams, *Assistant Professor of Chemistry, FAS–NB; Ph.D., Arizona*
Molecular design and synthesis; strategies, methods, and applications

Associate Member of the Graduate Faculty

Richard D. Ludescher, *Associate Professor of Food Science, CC; Ph.D., Oregon*
Protein structure, dynamics, and function; optical spectroscopy

Programs

The program has a large and diverse faculty with strengths in biophysical, bioinorganic, bioorganic, and biological chemistry; solid-state and surface chemistry; and theoretical chemistry. In addition, the faculty is grounded in the traditional disciplines of analytical, inorganic, organic, and physical chemistry. Members of the chemistry faculty are engaged in a variety of research efforts with researchers in other departments and other institutes at Rutgers and with their colleagues at Robert Wood Johnson Medical School.

Interdisciplinary research has increased substantially in recent years with the growth of several advanced technology centers on the Rutgers–New Brunswick campuses. These include the Center for Advanced Biotechnology and Medicine, the Center for Advanced Food Technology, the Malcolm G. McLaren Center for Ceramic Research, the Fiber Optics Research Center, and the Laboratory for Surface Modification.

Faculty and graduate student research is supported by in-house shop facilities (machine, electronics, and glassblowing), a comprehensive chemistry library, and a full range of state-of-the-art chemical instruments. This equipment includes 300, 400, 500, and 600 MHz NMR spectrometers with 2-D and 3-D capabilities, 200 MHz NMR spectrometers with solid-state capabilities, single-crystal and powder X-ray diffractometers, macromolecular crystallization and imaging facilities, ultrahigh vacuum surface analysis systems, and extensive laser and calorimetric instrumentation. Computing facilities in the Wright-Rieman Laboratories include several multiprocessor servers, a large array of graphics workstations, PC-based workstations, presenter systems, video-animation equipment, personal computers, X-terminals, and laser and color printers.

The program for the master's degree requires a minimum of 30 credits and either a critical essay or a thesis on some research problem. The program for the Ph.D. degree requires a thesis and an appropriate combination of course work and research credits. The master of philosophy degree is available to doctoral candidates.

A Ph.D. candidate must complete a minimum of 15 credits of course work. This phase includes 9 credits in his or her principal subfield of study (biological, inorganic, organic, or physical chemistry) and 6 credits chosen from among core courses in other subfields. The Ph.D. qualifying examination consists of a series of written cumulative examinations and the oral presentation and defense of a research proposal. There is no language requirement.

A Ph.D. candidate must spend not less than one academic year as a full-time student in residence. This residence requirement may be waived in cases of outstanding professional accomplishment and experience.

Most graduate courses are scheduled in the late afternoon and early evening hours. This enables students who are unable to attend classes during the day because of employment restrictions to pursue an M.S. degree.

Teaching assistantships and fellowships are available for both first-year and advanced graduate students, and virtually all full-time doctoral students receive financial support. Teaching assistants spend no more than six contact hours per week on their duties and normally take 6 to 10 credits of graduate courses or research each term. Fellowships normally do not entail special duties, and those who hold them can devote their time to course work and to research related to their Ph.D. dissertation. Further information on these and other matters may be found in the *Graduate Program in Chemistry,* a brochure available from the department.

Graduate Courses

16:160:501. (F) CHEMISTRY OF HETEROCYCLIC COMPOUNDS (3)
Prerequisites: 01:160:307,308, or equivalent.
Covers p-deficient (pyridine type) and p-excessive (pyrrole type) heterocyclic compounds. Emphasis on synthesis, reactivity, rearrangements, utility (in general organic synthesis), and biological activity.

16:160:503. (S) MODERN SYNTHETIC ORGANIC CHEMISTRY (3)
Prerequisite: 16:160:511.
Survey of preparative methods in organic chemistry and their application to the synthesis of complex molecules.

16:160:504. (S) RECENT ADVANCES IN ORGANIC CHEMISTRY (3)
Prerequisite: 16:160:511.
Selected newer topics discussed at an advanced level.

16:160:509. ORGANIC CHEMISTRY OF HIGH POLYMERS (3)
Prerequisites: 01:160:307,308 and 327,328, or equivalent.
Introduction to the synthesis and reactions of macromolecules, free-radical polymerization, stereospecific polymerization, and stepwise polymerization.

16:160:510. INTRODUCTION TO MOLECULAR MODELING (3)
Prerequisites: 01:160:307,308, 323,324; or equivalent.
Introduction to the use of computer-assisted molecular modeling techniques for the study of chemical problems; lectures on theoretical principles; instruction in use of modern modeling programs; computer projects involving solution of chemical problems.

16:160:511,512,513. ADVANCED ORGANIC CHEMISTRY I,II,III (3,3,3)
Prerequisites: 01:160:307,308, or equivalent.
Advanced survey of organic chemistry; molecular orbital theory, orbital symmetry correlations, structure and stereochemistry of organic molecules, chemistry of reactive intermediates, structure-reactivity relationships, molecular rearrangements.

16:160:515. (F) INTERPRETATION OF ORGANIC SPECTRA (3)
Prerequisites: 01:160:307,308, or equivalent.
Use of nuclear magnetic resonance, mass spectrometry, infrared and ultraviolet spectroscopy for the identification of organic compounds and the elucidation of organic reaction mechanisms.

16:160:518. (S) BIOORGANIC MECHANISMS (3)
Prerequisites: 01:160:307,308 and 327,328, or equivalent; 16:160:511.
Catalysis of organic reactions that are model systems for enzymatic processes. Emphasis on mechanisms of enzyme-catalyzed reactions.

16:160:520. (F) MATHEMATICAL METHODS OF CHEMISTRY (3)
Selected aspects of infinite series, vectors and matrices, functions of a complex variable, differential equations, and integral transforms as used in chemistry.

16:160:521. (F) ATOMIC AND MOLECULAR STRUCTURE (3)
Prerequisites: 01:160:327,328, or equivalent.
Introduction to the ideas of quantum chemistry and their application to the structure and properties of atoms and molecules.

16:160:522. STATISTICAL MECHANICS (3)
Prerequisites: 01:160:327,328, or equivalent.
Basic concepts and methods of equilibrium statistical mechanics. Applications to systems and phenomena of chemical interest, including ideal and real gases, chemical equilibria, phase transitions, classical liquids, polymer solutions.

16:160:525. (S) CHEMICAL THERMODYNAMICS (3)
Prerequisites: 01:160:327,328, or equivalent.
Principles of classical and statistical thermodynamics and their application to the study of homogeneous and heterogeneous equilibria.

16:160:526. PHYSICAL CHEMISTRY OF SOLUTIONS (3)
Prerequisite: 16:160:525.
Thermodynamics and statistical thermodynamic properties of solutions; Brownian motion and diffusion; Debye-Huckel theory of electrolytes.

16:160:527,528. PHYSICAL CHEMISTRY OF HIGH POLYMERS (3,3)
Prerequisites: 01:160:327,328, or equivalent.
Introduction to the physical chemistry of macromolecules aimed at understanding relations between molecular structure and physical properties of high polymers.

16:160:529. MOLECULAR SPECTROSCOPY (3)
Prerequisite: 16:160:521. Pre- or corequisite: 16:160:532.
Principles of electronic and vibrational spectroscopy of polyatomic molecules. Emphasis on the quantum-mechanical basis of the spectra and the ways in which spectra yield information about molecular properties.

16:160:531. PHOTOCHEMISTRY (3)
Prerequisites: 01:160:307,308 and 327,328, or equivalent.
Absorption of light; formation of electronically excited states and their subsequent chemical reactions; fluorescence, phosphorescence, and quantum yields; applications of photochemistry to organic systems.

16:160:532. QUANTUM MECHANICS (3)
Prerequisites: 16:160:520, 521.
Introduction to the principles of quantum mechanics with emphasis on operator approaches and the angular momentum problem. Approximate methods and application to simple examples.

16:160:533. CHEMICAL APPLICATIONS OF GROUP THEORY (3)
Prerequisite: 16:160:521 or equivalent.
Aspects and consequences of molecular symmetry; point groups and character tables; group theory and quantum mechanics; symmetry aspects of the electronic structure in organic and inorganic molecules; selection rules for electronic and vibrational spectroscopy; ligand field theory.

16:160:534. (S) CHEMICAL KINETICS (3)
Prerequisites: 01:160:327,328, or equivalent.
Chemical reaction rates, theories of molecular transformations, and the elucidation of reaction mechanisms.

16:160:535,536. Crystal and Molecular Structure I,II (3,3)
Prerequisites: 01:160:327,328, or equivalent. See also 16:635:564.
Symmetry of crystals; point and space groups. Determination of crystal structure by X-ray diffraction. Analysis of X-ray photographic and diffractometer data and its processing.

16:160:537. Biophysical Chemistry I (3)
Prerequisites: 01:160:327,328, or equivalent.
Introduction to the physical chemistry of proteins, nucleic acids, and their complexes. Forces that determine biopolymer structure. Principles of protein and nucleic acid structure. Transitions and interactions of biopolymers.

16:160:538. Biophysical Chemistry II (3)
Prerequisite: 16:160:537 or equivalent.
Introduction to biophysical techniques used in the study of structure and function. Theoretical methods of macromolecular analysis. Methods of macromolecular engineering and design.

16:160:539. Protein Engineering and Design (3)
Prerequisites: 01:160:307,308 and 11:115:403,404, or equivalent, or permission of instructor; 16:160:537 strongly recommended.
Protein structure. Protein structure-function relationships. Protein engineering methods. Protein engineering to modify the properties of existing useful proteins (e.g., ligand recognition, catalysis, allostery, stability) and to create new useful proteins. Catalytic antibodies. Semisynthetic proteins. Denovo protein design.

16:160:540. Single-Crystal X-Ray Analysis Laboratory (1)
Prerequisite: 16:160:535. Corequisite: 16:160:536.
Laboratory course to accompany 16:160:536. Characterization of crystals and introduction to diffractometry.

16:160:541,542. Special Topics in Physical Chemistry (3,3)
Prerequisites: 01:160:327,328, or equivalent.
Advanced topics of current interest.

16:160:543,544. Special Topics in Biological Chemistry (1-3 BA,1-3 BA)
Prerequisites: 16:160:537, 538, or equivalent.
Advanced topics of current interest.

16:160:546. Chemical Separations (3)
Prerequisite: 01:160:348 or equivalent.
Principles of chemical separations by various chromatographic techniques.

16:160:548. Special Analytical Methods (3)
Prerequisite: 01:160:348 or equivalent.
Advanced topics in analytical chemistry.

16:160:549. Electroanalytical Chemistry (3)
Prerequisite: 01:160:348 or equivalent.
Application of electrochemical principles and techniques, including modern polarographic methods, voltammetry, potentiometry, and chronopotentiometry.

16:160:551. Analytical Spectroscopy (3)
Prerequisite: 01:160:348 or equivalent.
Theory of spectroscopy and spectrophotometry, including the analytical applications of spectrochemical methods.

16:160:571. (F) Advanced Inorganic Chemistry (3)
Prerequisite: 01:160:371 or equivalent.
Survey of bonding, electronic-structural, and magnetic properties of transition metal complexes, followed by a survey of the kinetics and mechanisms by which such materials undergo substitution, isomerization, and redox reactions.

16:160:575. (S) Principles of Organometallic Chemistry (3)
Prerequisites: 01:160:307,308, 371, or equivalent.
Detailed survey of the mechanisms of organometallic reactions.

16:160:576. Bioinorganic Chemistry (3)
Prerequisite: 01:160:371 or equivalent.
Spectroscopic, chemical, and other properties of metal-containing biological systems such as hemoglobin, vitamin B_{12}, and carboxypeptidase.

16:160:577. (S) Solid-State Chemistry (3)
Prerequisites: 01:160:371, 421, or equivalent.
Relation between crystal structure, bonding and physical properties of solids, imperfections in solids; nonstoichiometric compounds; electronic and magnetic properties of various types of solids; transformation in solids; solid-state reactions; crystal growth; solid-state electrochemistry.

16:160:579. Special Topics in Inorganic Chemistry (3)
Prerequisite: 01:160:371 or equivalent.
Advanced topics of current interest.

16:160:601,602. Independent Studies in Chemistry (BA,BA)
Individualized instruction supervised by a faculty member.

16:160:603. Introduction to Research (1)
Enrollment restricted to first-year Ph.D. students in chemistry.
Introduction to doctoral and postdoctoral research in chemistry. Identification of research problems. Presentation of research results. Use of chemical literature. Research proposals and funding. Research ethics.

16:160:605,606. Laboratory Rotation in Chemistry I,II (1-3 BA,1-3 BA)
Enrollment restricted to Ph.D. students in chemistry. No more than a total of 6 credits of laboratory rotation can be earned.
Introduction to the techniques of chemical research through participation in research projects of selected members of the graduate faculty.

16:160:611,612. Seminar in Chemistry (1,1)
For second- and third-year Ph.D. students.
Student seminars on topics of current interest in chemistry.

16:160:701,702. Research in Chemistry (BA,BA)

CIVIL AND ENVIRONMENTAL ENGINEERING 180

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Nenad Gucunski, Civil and Environmental Engineering Building, Busch Campus (732/445-2232)**
Email: *gucunski@rci.rutgers.edu*

Members of the Graduate Faculty

Perumalsamy N. Balaguru, *Professor of Civil and Environmental Engineering, SE; Ph.D., Illinois (Chicago)*
Concrete structural systems; composite materials; construction management
Maria Boilé, *Assistant Professor of Civil and Environmental Engineering, SE; Ph.D., New Jersey Institute of Technology*
Transportation planning; intermodal transport; mass transit; transport economics
Nenad Gucunski, *Professor of Civil and Environmental Engineering, SE; Ph.D., Michigan*
Soil-structure interaction; nondestructive testing; numerical methods; soil and structural dynamics; earthquake engineering
Qizhong Guo, *Associate Professor of Civil and Environmental Engineering, SE; Ph.D., Minnesota; P.E.*
Environmental hydraulics; water quality modeling; water resources and environmental engineering
Kenneth Y. Lee, *Assistant Professor of Civil and Environmental Engineering, SE; Ph.D., California (Irvine)*
Groundwater engineering; numerical modeling; water resources; contaminant flow
Ali Maher, *Chair and Professor of Civil and Environmental Engineering, SE; Ph.D., Michigan*
Soil/site improvement; soil composite materials; geosynthetics; soil dynamics; environmental geotechnology

Monica Mazurek, *Assistant Professor of Civil and Environmental Engineering, SE; Ph.D., California (Los Angeles)*
Air quality engineering; organic geochemistry; analytical chemistry for environmental systems

Husam Najm, *Assistant Professor of Civil and Environmental Engineering, SE; Ph.D., Michigan; P.E.*
Structural system design; bridge design; concrete material

Hani H. Nassif, *Assistant Professor of Civil and Environmental Engineering, SE; Ph.D., Michigan; P.E.*
Analysis and design of bridges; reliability analysis; structural modeling and analysis

Edward G. Nawy, *Professor of Civil and Environmental Engineering, SE; D.Eng., Pisa; P.E.*
Structural concrete; materials and systems; cold weather concrete construction

Kaan M.A. Ozbay, *Associate Professor of Civil and Environmental Engineering, SE; Ph.D., Virginia Polytechnic Institute*
Transportation and traffic engineering; intelligent transportation systems; net - work flows, traffic simulation; real-time traffic control

Trefor P. Williams, *Associate Professor of Civil and Environmental Engineering, SE; Ph.D., Georgia Institute of Technology; P.E.*
Construction management; traffic engineering; decision support systems; neural networks

Yook-Kong Yong, *Professor of Civil and Environmental Engineering, SE; Ph.D., Princeton; P.E.*
Structural mechanics; computational mechanics; composite plates; finite element analysis

Adjunct Members of the Graduate Faculty

Joseph Berechman, *Visiting Professor of Civil Engineering, SE; Ph.D., Pennsylvania*
Transportation economics; transportation systems; modeling and planning; policy analysis and evaluation; urban economics; urban land use modeling

Reuben Karol, *Visiting Professor of Civil Engineering, S.E.; M.S., Rutgers*
Soil grouting

Steven J. Medlar, *Visiting Professor of Environmental Engineering, SE; M.S., Tufts*
Wastewater treatment; chemical feed; water quality and treatment

Programs

Programs of graduate study leading to the M.S. and Ph.D. degrees may be arranged in a wide variety of areas. The fields of specialization available include structural analysis and design, computational mechanics, structural reliability, structural optimization, structural dynamics, concrete structures, experimental mechanics, soil mechanics and foundations, soil dynamics, soil composite materials, constitutive modeling of geomaterials, hydraulic engineering, hydromechanics, coastal studies, water and wastewater treatment, environmental fluid mechanics, water resource systems, transportation engineering, intelligent transportation systems, transportation infrastructure design operations, construction engineering, and management.

Students with a B.S. degree from an accredited civil engineering field may apply for direct admission to the graduate program. Students with backgrounds in engineering programs other than civil engineering are required to complete certain prerequisite undergraduate courses in civil engineering.

Master of science degree candidates may elect either a thesis or nonthesis option. The thesis option consists of 24 credits of course work, 6 credits of research in a specialized area, and a final thesis presentation. In the nonthesis option, a candidate must complete 27 credits of course work, do a 3-credit special project with a report, and pass an oral final examination.

Requirements for the M.S. degree may be satisfied for all options in a part-time evening program, which is designed for students employed in industry and other students whose obligations preclude full-time study. Admission and academic standards for part-time students are the same as for full-time students. This arrangement makes it possible for students to combine day and evening schedules simultaneously or at different periods in their academic careers.

The master of philosophy degree is available to doctoral students.

The degree of doctor of philosophy is primarily a research degree and is not conferred solely for completion of a series of prescribed courses. The requirements for the Ph.D. degree include a minimum of 48 credits of course work beyond the baccalaureate, a minimum of 24 credits of research beyond the M.S. degree, and successful completion of a research dissertation. There is no language requirement. Ph.D. candidates normally are required to register for at least two consecutive terms as full-time students in residence. Exceptions to this requirement may be made in special situations.

Significant computing and experimental laboratory resources are available to graduate students. The computer resources of the School of Engineering include a design, simulation, and visualization (DSV) lab with 60 Sun Ultra 10 workstations. Located within the School of Engineering is the Supercomputer Remote Access and Graphics Center, which provides facilities for developing large-scale computational programs, for high-speed access to the National Science Foundation's Supercomputer Centers, and for graphical processing and display. Students in the Department of Civil and Environmental Engineering have access to a graduate civil engineering laboratory and to the Rutgers Intelligent Transportation Systems (RITS) computing laboratories. The laboratories provide excellent computational capabilities, software packages specific to civil/environmental engineering, and access to supercomputing resources. A number of research laboratories are used to complement theoretical and analytical course work and for doctoral and master's thesis research. These laboratories include the Concrete Structures and Materials Laboratory, the Environmental Engineering Laboratory, the Fluid Mechanics and Environmental Hydraulics Laboratory, the Large-Scale Structural Laboratory, the Rutgers Asphalt Pavement Laboratory (RAPL), the Soil Dynamics and Highway Materials Laboratory, and the Soil Mechanics Laboratory. Additional research opportunities are provided through the department's Center for Advanced Infrastructure and Transportation (CAIT).

Degree programs in civil and environmental engineering may be arranged with the program director. Details may be found in *Program Information Manual for Graduate Students,* available on request from the program office.

Graduate Courses

16:180:501. (F) ANALYTICAL METHODS IN CIVIL ENGINEERING (3)
Yong
Review of series solutions of differential equations; perturbation methods, applications in civil engineering; derivations of well-posed partial differential equations for engineering problems and their classical solutions; Fourier analysis; applications of probability and statistics to model loads and responses of engineering systems.

16:180:514. (S) COMPOSITE MATERIALS IN CIVIL ENGINEERING (3)
Balaguru, Najm. Prerequisite: 14:180:243.
Fundamental aspects of composites and their practical applications; design guidelines and methodologies for structural shapes and for reinforcement of concrete, steel, and timber structures. FRP rebars, bonded plates, bonded fabrics, and fiber wraps. Application exercises for conventional products that combine material fabrication and design concepts.

16:180:515. (F) STRUCTURAL ANALYSIS (3)
Balaguru
Principle of superposition as applied to statically indeterminate structures; energy methods; approximate methods for the analysis of trusses and frames; failure theories; plastic analysis; introduction to matrix methods for structural analysis; analysis of composite structures.

16:180:516. (S) ADVANCED STRUCTURAL DESIGN I (3)
Nassif
Topics include elastic and inelastic column and plate buckling; plate girder design; bracing design; structural modeling and analysis; bridge design; composite design; connections.

16:180:517. (F) STRUCTURAL DYNAMICS (3)
Yong
Analysis of structural members and systems subjected to dynamic loads; single-degree-of-freedom and multi-degree-of-freedom analytical models of civil engineering structures; free vibrations, harmonic and transient excitation, foundation motion, response spectrum, Lagrange's equation; modal superposition and direct integration methods; response by a general purpose dynamic computer code.

16:180:518. (F) DESIGN FOR LATERAL LOADS (3)
Najm. Prerequisites: 16:180:517, 14:180:413, or equivalent.
Fundamentals of seismic analysis and design of buildings and bridges; earthquake ground motion, earthquake characterization response spectra, time history, inelastic response of structures, and ductility demands; modeling and analysis of structures, structural systems, performance-based design, and seismic design codes; design of shear walls, moment connections, bracings, deep foundations, and isolation bearings; seismic detailing; seismic retrofit and earthquake protection systems; introduction to wind load design.

16:180:519. (F) ADVANCED STRUCTURAL ANALYSIS (3)
Balaguru
Rigorous matrix formulation of the stiffness and flexibility methods of structural analysis applied to skeletal structures. Development of computer programs for the analysis of space and plane trusses and frames.

16:180:522. (S) FINITE ELEMENT METHODS IN CIVIL ENGINEERING (3)
Yong. Prerequisite: 14:180:402 or 16:180:515.
General finite element formulation of two- and three-dimensional boundary-value problems; advanced finite element techniques; finite element formulation problems in continuum mechanics; applications in civil engineering problems; use of a general purpose finite element software package; introduction to the boundary element method.

16:180:523. (S) STRUCTURAL OPTIMIZATION (3)
Prerequisite: 16:180:519.
Developments in optimal structural design. Optimality criteria methods. Formulation of structural design problems as optimization problems using special techniques, linear and nonlinear optimization methods. Fully stressed design versus optimal design.

16:180:524. (S) BRIDGE DESIGN I (3)
Nassif. Prerequisites: 14:180:413, 426.
History, development, and classification of bridges; use of LRFD-AASHTO specifications for the design of basic straight-girder type bridges, including composite and noncomposite I and box girders; simple and continuous spans; substructure design; field testing and monitoring; and repair and rehabilitation.

16:180:525. STRUCTURAL RELIABILITY (3)
Nassif
Elements of probability theory and its application to structural engineering, statistical distributions of load, probable strength of structural elements, safety analysis and reliability prediction of structural systems, and reliability-based design codes.

16:180:526. STRUCTURAL STABILITY (3)
Prerequisite: 16:180:515.
Elastic and inelastic buckling of members under pure compression, pure moment, and combined compression and moment; local buckling; buckling of frames, plates, and shells.

16:180:527. BRIDGE DESIGN II (3)
Nassif
Advanced bridge-analysis methods, such as the grillage analogy, semicontinuum method, and orthotropic-plate method; design of cable-stayed bridges; dynamic analysis of bridges; bridge testing, monitoring, and instrumentation techniques; nondestructive testing of bridges; bridge inspection and rehabilitation.

16:180:531. TRAFFIC ENGINEERING (3)
Boilé, Ozbay
Techniques and hardware used for real-time traffic-data collection, sources of errors and sample-size determination; design parameters, including economic and human factors, as well as environmental constraints; experiment design for model-development and transportation-operations analyses; deterministic and stochastic models of traffic processes, including queuing theory, headway distributions, and gap acceptance; stream-flow characteristics, including car-following and multilane models, bottleneck, fuel consumption, and noise models; models for automatic vehicle control; network operations; models for modes of traffic; traffic control, short-term planning, and system evaluation.

16:180:532. TRANSPORTATION PLANNING (3)
Boilé, Ozbay
Intelligent Transportation Systems (ITS) projects in the United States, Europe, and Japan; advanced traveler-information systems; advanced traffic-management systems; automated highway systems; commercial vehicle operations; operational field tests; system architecture; human factors; safety; institutional and legal issues; multimodal ITS applications; modeling ITS as hybrid systems; evaluation and selection of candidate Intelligent Transportation Systems.

16:180:533. TRAFFIC OPERATIONS (3)
Boilé, Ozbay
Real-time transportation operations; transportation-system evaluation; demand modeling; time-sensitive transportation problems, including real-time traffic control and networkwide feedback control; linear and nonlinear network optimization; deterministic and stochastic queuing models of the control of rush hour traffic, traffic-signal timing, and ramp metering; incident management; operations; strategic versus tactical transportation infrastructure planning; operation of parking facilities; congestion management strategies; automatic vehicle control.

16:180:534. DESIGN OF TRANSPORTATION FACILITIES (3)
Boilé, Ozbay
Software and hardware to design, test, and evaluate transportation systems; field studies, development and use of computer models, and instrumentation of small- and full-scale hardware models; geographic-information systems, artificial intelligence, and computer graphics for design and evaluation; optimization software for vehicle scheduling and routing and traffic assignment; visual-simulation development tools for rapid prototyping of selected transportation systems; simulated life-cycle analysis and validation techniques; data acquisition and control; advanced data-visualization tools to test and evaluate developed models.

16:180:535. (F) MECHANISTIC PAVEMENT DESIGN (3)
Staff
Pavement design principles for new and rehabilitated pavements. Material characterization, flexible and rigid pavement design, laboratory and field data collection and analysis, pavement-management practices. Deflection back calculation and pavement-design software.

16:180:536. (S) TRANSPORTATION SYSTEMS ANALYSIS (3)
Boilé. Prerequisites: Calculus and basic probability.
Systems analysis and decision making using concepts from economics, engineering, public policy analysis, operations research, and management science; application to transportation systems; and use of computer applications and case studies.

16:180:537. INTELLIGENT TRANSPORTATION SYSTEMS (3)
Ozbay
Focuses on Advanced Traveler-Information Systems (ATIS) and advanced traffic-management components of Intelligent Transportation Systems (ITS). Students also learn about Commercial Vehicle Operations (CVO), Advanced Vehicle-Control Systems (AVCS), and Advanced Rural Transportation Systems (ARTS).

16:180:538. (S) FREIGHT TRANSPORTATION SYSTEMS (3)
Boilé
Freight transportation demand and supply models, freight network modeling, freight flow forecasting, operating, service, and cost characteristics. Case studies in the analysis and design of freight transportation systems.

16:180:541. (F) ADVANCED REINFORCED CONCRETE I (3)
Nawy
Ultimate load theories in flexure, shear, diagonal tension, and torsion of symmetrical and nonsymmetrical members; behavior of compression members in uniaxial and biaxial compression, stability of long columns; first-order and second-order solutions and the P- effects; serviceability behavior and theories for deflection and cracking of one- and two-dimensional members; wind analysis and continuity in floor systems and frames; failure mechanisms in two-way slabs and plates; energy-design solutions; seismic design of concrete structures.

16:180:542. (S) Advanced Reinforced Concrete II (3)
Nawy
High-strength, high-performance concretes and composites; long-term effects; performance characteristics; biaxial and triaxial confinement; micro- and macromechanics of concrete; fracture-mechanics theory; shear transfer in multilayered systems; limit theory at failure of indeterminate concrete frames and continuous beams; moment redistribution and ductility of joints; plastic hinging and rotational capacities of confined-concrete members and structural systems; membrane and bending theories for the design and analysis of concrete shells and folded plates, including buckling behavior.

16:180:544. (S) Prestressed Concrete (3)
Nawy
Theory of prestressed concrete; partial loss in prestressing and long-term effects due to creep, shrinkage, and relaxation; service-load and ultimate-load evaluation of pretensioned and posttensioned elements in flexure, shear, and torsion; camber, deflection, and crack control; two-way prestressed concrete-floor systems; prestressed portal frames; posttensioned liquid- and gas-retaining circular tanks; prestressed shells and dome roofs for circular tanks.

16:180:545. (F) Advanced Construction Engineering Management I (3)
Balaguru, Williams. Prerequisites: 14:180:406,407, or equivalent.
Advanced techniques for financial and management control of construction projects; construction company financial control and accounting; project cost control; estimating and bid preparation; equipment management; computer and expert-system applications to construction financial control.

16:180:546. (S) Advanced Construction Engineering Management II (3)
Williams. Prerequisites: 14:180:406,407, or equivalent.
Analytical techniques for control of construction operations; network-scheduling techniques (CPM and PERT); computerized scheduling; linear programming applied to construction; simulation of construction operations; decision and risk analysis.

16:180:553. (S) Theory and Analysis of Plates and Shells (3)
Yong. Prerequisite: 16:180:501.
Review of elastic equations; Kirchoff-Love and Mindlin plate theories; classical and numerical solutions; theory and applications of shells; finite-element analysis of plate and shell structures.

16:180:561. (F) Advanced Water Supply and Sewerage (3)
Medlar
Development of sources of water supply; information analysis; design of collection, transmission, and distribution systems. Hydraulics and design of sewers.

16:180:562. (S) Design of Water and Wastewater Treatment (3)
Medlar
Functional study of plant loadings in relation to degree of treatment desired; layout, analysis, and design of treatment process units; mechanical and thermal-energy requirements and equipment.

16:180:563. (F) Advanced Hydrology (3)
Staff
Hydrologic processes and modeling: evapotranspiration, infiltration, precipitation and snow melt, overland flow, subsurface and surface flow relations, channel and watershed routing; hydraulic flood routing, numerical methods; watershed modeling; stochastic processes in hydrology; flood and drought risks, flood plain analysis and management.

16:180:564. (S) Unit Processes in Environmental Engineering (3)
Theory and laboratory experiments demonstrating the design requirements associated with unit processes in water and sewage treatment. Advanced methods of analysis such as spectroscopy, potentiometry, polarography, conductivity, and chromatography.

16:180:565. (S) Biogeochemical Engineering (3)
Mazurek. Prerequisites: 01:160:159-160, 161-162.
Transformation of organic chemicals in sediments (marine, estuarine) and freshwater environments; roles of microorganisms highlighted in examples of biogeochemical processes occurring in environmental matrices. Chemical processes and physical environment in natural (unperturbed) and polluted systems along with the degradation of biogenic and anthropogenic organic compounds. Molecular tracers specific to biogeochemical process as part of contemporary case studies.

16:180:566. (F) Sediment Transport (3)
Guo
Erosion, transport, and deposition of sediment within a watershed and especially the fluvial network; flow resistance in natural channels; suspended load, bed load, and total load; noncohesive versus cohesive sediment; sedimentation; sediment transport as an index of pollutant movement; numerical modeling and field sampling.

16:180:567. (S) Analysis of Receiving Water Quality (3)
Introduction to mathematical modeling of water quality; well-mixed versus partially mixed water bodies; turbulent diffusion, velocity-induced dispersion; reaction kinetics; biological processes, growth kinetics, BOD, dissolved oxygen, photosynthesis; development of water-quality models.

16:180:568. (S) Thermal Effects on Receiving Waters (3)
Modes of heat transfer, energy equation; heat balance in well-mixed water bodies; heat exchange between atmosphere and water body; temperature dynamics in well-mixed bodies; thermal stratification in streams and reservoirs; heat dispersion; thermal jets and plumes; cooling ponds; temperature effects on water-quality parameters.

16:180:571. (F) Advanced Soil Mechanics (3)
Gucunski
Elasticity and plasticity models; stress-strain relations for soils; failure criteria; elastic solutions for half-space and layered systems; one- and three-dimensional consolidation theory; computer applications.

16:180:572. (S) Soils Engineering (3)
Maher
Earth pressure theories; stability of natural slopes and open cuts; stability of built embankments, earthquake effects, rapid drawdown and seepage problems, slope-stabilization techniques; retaining walls; computer application in slope stability.

16:180:574. (S) Groundwater Engineering I (3)
Lee
Porous media; fundamental equations of groundwater flow; confined flow; unconfined flow; hydraulics of wells; numerical methods; groundwater contamination; investigation; remediation and cleanup; monitoring; computer applications.

16:180:575. (F) Theoretical Soil Mechanics (3)
Gucunski. Prerequisites: 16:180:501, 571.
Theory of semi-infinite elastic media; elastic equilibrium. Stress-strain behavior of soils, constitutive models for soils. Applications of plasticity models to compute soil behavior.

16:180:576. (S) Groundwater Engineering II (3)
Lee. Prerequisite: 16:180:574.
Solute and particle transport; dissolution of nonaqueous phase liquids; aqueous geochemistry; chemical property estimation; numerical modeling and analysis; analytical and stochastic techniques; computer applications.

16:180:577. (F) Advanced Foundation Engineering (3)
Staff. Lec. 2 hrs., design lab. 3 hrs. Prerequisites: 16:180:571, 572.
Subsurface investigations; site preparation and improvement; flexible retaining structures; caissons; drilled shafts; underground structures; pile foundations; foundations subjected to dynamic loads; marine structures; environmental effects of construction.

16:180:578. (S) Soil Dynamics (3)
Gucunski
Review of basic vibration theories as applied to soil dynamics; elastic wave propagation in soils; elements of seismic soil explorations; dynamic soil properties; laboratory evaluation of dynamic soil properties; liquefaction; machine foundations; fundamentals of soil-structure interaction; earthquake engineering; computer applications.

16:180:580. (S) Engineering Rock Mechanics (3)
Methods of rock exploration, physical and mechanical properties of rocks; deformation; in situ strength; hydrothermal effects on rocks; stability of rock masses; state of stress and strain around tunnels, shafts, and domes; stabilization of rocks.

16:180:581. (S) Physicochemical Properties and Stabilization of Soils (3)
Maher
Relationship between physical properties and selected chemical and mineralogical characteristics emphasizing fine-grained and colloidal fractions; problems affecting site use, including weak, compressible soil; high shrink-swell potential and erodibility; stabilization techniques, including compaction, earth reinforcement, drainage and erosion control, admixture stabilization, precompression, grouting.

16:180:582. (S) Earthquake Engineering: Dynamic Soil-Structure Interaction (3)
Gucunski
Seismicity; size of earthquakes; estimation of ground motion parameters; seismic hazard analysis; site response analysis; design ground-motion building-code provisions; soil-structure interaction effects and formulation; simplified models; solutions in frequency and time domains.

16:180:586. (S) Advanced Fluid Mechanics (3)
Guo
Basic laws and equations of fluid flows; exact and approximate solutions; potential flows; boundary layer flows; turbulent flows in pipes and open channels; free turbulent jets and wakes; turbulence and transport phenomena; transient flows.

16:180:588. (S) Theory of Hydraulic Models (3)
Geometric, kinematic, and dynamic similarity between prototypes and models. Similarity laws; model techniques; undistorted and distorted models; models for hydraulic structures, free-surface flows, flows over erodible beds, and hydraulic machinery. Environmental applications.

16:180:590. (S) Coastal Engineering (3)
Guo
Generation and propagation of tides; salinity intrusion, pollutant flushing, and sedimentation in estuaries; circulation in the coastal ocean; coastal water-quality modeling; coastal wetlands; gravity waves; coastal erosion; coastal-structure design.

16:180:601,602. Advanced Topics in Civil Engineering (BA,BA)
Selected topics of current interest in any specialized field of civil engineering.

16:180:611,612. Advanced Topics in Environmental Engineering (BA,BA)
Selected topics of current interest in any specialized field of environmental engineering.

16:180:691,692. Seminar in Civil and Environmental Engineering (N0,N0)
Contemporary developments and special topics in research and engineering design in civil and environmental engineering presented and discussed by faculty, students, and invited speakers.

16:180:693,694. Special Project (3,3)
Nonthesis study. Special project under the supervision of a professor. Requires a technical report.

16:180:701,702. Research in Civil and Environmental Engineering (BA,BA)
Thesis work for M.S. or Ph.D. degree.

CLASSICS 190

Degree Programs Offered: Master of Arts, Master of Arts for Teachers, Doctor of Philosophy
Director of Graduate Program: Professor Sarolta A. Takács, 004 Ruth Adams Building, Douglass Campus (732/932-9797)
Web Site: *http://classics.rutgers.edu*

Members of the Graduate Faculty

Robert H. Bolton, *Professor of Philosophy, FAS–NB; Ph.D., Michigan*
  Ancient philosophy; philosophy of language; metaphysics
T. Corey Brennan, *Associate Professor of Classics, FAS–NB; Ph.D., Harvard*
  Roman history
Jack L. Cargill, *Professor of History, FAS–NB; Ph.D., California (Berkeley)*
  Greek history and epigraphy
Lowell Edmunds, *Professor of Classics, FAS–NB; Ph.D., Harvard*
  Greek literature, mythology, intellectual history
Thomas J. Figueira, *Professor of Classics and Ancient History, FAS–NB; Ph.D., Pennsylvania*
  Greek political history; the social history of classical antiquity; Greek prose
William W. Fortenbaugh, *Professor Emeritus of Classics, FAS–NB; Ph.D., Pennsylvania*
  Ancient philosophy
Archer St. Clair Harvey, *Associate Professor of Art History, FAS–NB; Ph.D., Princeton*
  Late antique and early Christian art
John F. Kenfield III, *Associate Professor of Art History, FAS–NB; Ph.D., Princeton*
  Greek and Roman art
David Marsh, *Professor of Italian, FAS–NB; Ph.D., Harvard*
  Classical influences on Renaissance literature
Pierre Pellegrin, *Visiting Professor of Philosophy, FAS–NB; Professor of Philosophy, CREA(France); Ph.D., Paris I*
  Ancient philosophy
Stephen Reinert, *Associate Professor of History, FAS–NB; Ph.D., California (Los Angeles)*
  Byzantine history
Michael David Rohr, *Associate Professor Emeritus of Philosophy, FAS–N; Ph.D., Stanford*
  Ancient philosophy
Kirk R. Sanders, *Assistant Professor of Classics, FAS–NB; Ph.D., Texas (Austin)*
  Ancient philosophy
Jocelyn P. Small, *Professor of Art History, FAS–NB; Ph.D., Princeton*
  Classical art and archaeology, iconography, Etruscology
Sarolta A. Takács, *Associate Professor of Classics, FAS-NB; Ph.D., California (Los Angeles)*
  Roman religion, Roman and Byzantine history
Gerald Verbrugghe, *Associate Professor of Classics, FAS–C; Ph.D., Princeton*
  Roman history and historiography
Steven F. Walker, *Professor of Comparative Literature, FAS–NB; Ph.D., Harvard*
  Hellenistic literature

Programs

Graduate training in the Department of Classics focuses on interpreting the original Latin and Greek in the light of modern literary criticism and archaeological data. It also makes use of the theories and methodologies of other disciplines that deal with ancient Greece and Rome, namely ancient history, art history, philosophy, and epigraphy. While the study of original texts is central, the program attempts to relate these texts to the present day. The aim is to prepare students to apply their knowledge of the classics to the general humanistic tradition.

The Ph.D. candidate is expected to have a knowledge of all major authors, including work beyond the Greek fourth and fifth centuries B.C. and the Republican and Augustan periods of Rome. While the candidate is expected to research a specific aspect of the classics, he or she also should be acquainted with the interdependence of Greek and Roman culture.

Students may supplement their work with related programs, such as art history, comparative literature, or philosophy. Additionally, the graduate program in classics participates in the Transliteratures program (q.u.).

The M.A. candidate must demonstrate a general knowledge of the principal ancient authors and may write a thesis (equivalent to 6 credits). While the candidate may emphasize either Greek or Latin, he or she must have a knowledge of both languages. The student also is expected to demonstrate a reading knowledge of French, German, or Italian. The M.A. examination tests the candidate's knowledge of the Greek and Latin languages, of course material, and of material on the general reading list. It consists of three hours of translation and three hours of general questions in history, literature, and philosophy. Students may take the M.A. examination after completing 30 credits of graduate work. General reading lists for the M.A. and Ph.D. degrees are available to all graduate students at the department office. Reading lists for special fields and authors can be worked out with the graduate adviser.

The M.A. program in Latin for teachers is designed to assist Latin teachers in secondary schools. Candidates are expected to pass a competency test in ancient Greek, but they may bypass this requirement by demonstrating a reading knowledge of French, German, or Italian. The student is expected to complete a total of 30 credits, of which 24 are graduate credits. The remaining 6 credits are to be taken outside of Latin literature in such areas as ancient history and ancient philosophy. In addition, candidates must complete an expository or critical essay, which normally relates to course work, and they must pass a comprehensive examination based on course work and the reading list of Latin authors.

The Ph.D. candidate is expected to complete at least 48 credits of course work beyond the bachelor's degree and to demonstrate a reading knowledge of German and either French or Italian. Course work includes Greek or Latin composition. This requirement may be waived upon successful completion of equivalent written work. The qualifying examination covers the following four areas, with a three-hour examination in each: (1) a knowledge of the principal Greek and Latin authors as specified on the reading list; (2) a particular Greek or Latin author; (3) a special field, such as a period of ancient literature, a literary genre, ancient philosophy, or a period of Greek or Roman art and archaeology or history; and (4) translation from Latin and Greek. The master of philosophy degree is available to doctoral candidates.

After he or she completes satisfactorily the qualifying examination, the Ph.D. candidate forms a dissertation committee, which must include three professors on the graduate faculty of the Department of Classics and one professor from outside this group. The candidate then submits a dissertation proposal to this committee for approval. The proposal includes a general statement of the project, a list of chapters and of topics to be treated within each chapter, and an annotated bibliographical survey. The candidate must have his or her proposal in an acceptable form within the term that follows the qualifying examination.

An interdisciplinary Ph.D. in art history and classical archaeology may be worked out with advisers from the art history and classics programs. Students in such a program would have to show proficiency in French, German, Greek, and Latin. A concentration in interdisciplinary classical studies and ancient history is available for M.A. and Ph.D. candidates. Applications for this option are expected to possess a background in Greek and Roman history in addition to the other qualifications for admission to the classics program. Specialized M.A. and doctoral reading lists are provided for this concentration, and special field/special author examinations for the Ph.D. are focused on classical history. Doctoral candidates are examined on their knowledge of Greek and Roman history.

Graduate Courses

Two or three of the following courses are offered each term:

16:190:503. INTRODUCTION TO GRADUATE LITERARY STUDY: LATIN (3)
Close readings and basic critical techniques of interpreting Latin literature.

16:190:504. INTRODUCTION TO GRADUATE LITERARY STUDY: GREEK (3)
Close readings and basic critical techniques of interpreting Greek literature.

16:190:505. STUDIES IN CLASSICS (3)
Topics in the field of classics selected for special study.

16:190:507,508. READINGS IN CLASSICS (3,3)
Readings in areas of special interest in Latin and/or Greek authors.

16:190:509. PROSEMINAR: MATERIALS AND METHODS (3)
Prerequisite: Reading knowledge of Latin and Greek.
Introduction to the discipline of classical philology. Topics covered include bibliography, lexicography, linguistics, textual history and criticism, geography, paleography, papyrology, epigraphy, and literary theory.

16:190:510. HELLENISTIC LITERATURE (3)
Extensive readings in the major authors of the Hellenistic Age (350–30 B.C.), especially those who influenced Roman literature and thought.

16:190:511. GREEK LITERATURE OF THE ROMAN PERIOD (3)
Greek authors of the Roman period (30 B.C.–A.D. 500) selected with a view to their influence on the literature and thought of the Roman Empire.

16:190:519,520,521,522. LATIN LITERATURE SEMINAR (3,3,3,3)
Work of a different Latin author (for example, Catullus, Propertius/Tibullus, Virgil, Ovid/Petronius). Offered during Summer Session.

16:190:523. SEMINAR ON ROME AND POMPEII (3)
Research and instruction at Rutgers and in Italy on Rome and Pompeii. Includes oral presentations and a paper.

16:190:525. HISTORIANS OF REPUBLICAN ROME (3)
Critical reading of selected fragments from Roman annalistic writers, and an intensive study of the historical writings of Caesar and Sallust.

16:190:526. HISTORIANS OF IMPERIAL ROME (3)
Selected major Greek and Latin texts for the history of the Roman Empire. The periods covered by Tacitus to Ammianus Marcellinus.

16:190:530. ARISTOTLE: CONSTITUTION OF THE ATHENIANS (3)
Analysis of Aristotle's *Athenaion Politeia* and other documents pertaining to the development of Greek political institutions.

16:190:557. HOMER (3)
The *Iliad* and *Odyssey* in their historical, literary, and cultural backgrounds.

16:190:559,560. PLATO (3,3)
Several major dialogues of Plato studied with special emphasis on the philosophical problems they raise.

16:190:562. ATTIC HISTORIOGRAPHY (3)
Greek history of the sixth and fifth centuries B.C. in the Greek historiographic tradition. Emphasis on detailed study of the texts, especially Thucydides.

16:190:563,564. GREEK DRAMA (3,3)
Tragedians: Aeschylus, Sophocles, and Euripides; the comedies of Aristophanes.

16:190:565. HERODOTUS (3)
Study of the beginnings of the Greek historiographic tradition in the sixth and fifth centuries B.C., with primary emphasis on Herodotus.

16:190:566,567. ANCIENT NOVELS (3,3)
Greek and Roman prose fiction of the postclassical period in its literary and sociohistorical contexts.

16:190:569. ADVANCED GREEK PROSE COMPOSITION (3)
Study of the styles of Attic prose of the fifth and fourth centuries and composition in the manner of select authors of classical Attic Greek.

16:190:570. ADVANCED LATIN PROSE COMPOSITION (3)
Study of the stylistic development of Latin prose and composition in the manner of select classical authors.

16:190:571. ROMAN DRAMA (3)
Selected works from the dramatic literature of Rome.

16:190:573. ANCIENT COMEDY (3)
Study of the conventions of Greek and Roman comedy.

16:190:575. VERGIL (3)
The *Eclogues, Georgics,* or *Aeneid* of Vergil, with attention to literary predecessors, cultural context, influence, and ancient and modern criticism.

16:190:579. PROBLEMS IN AUGUSTAN LITERATURE (3)
Individual topics for research and criticism involving relationships among the elegiac poets, Horace, and Vergil.

16:190:612. GREEK AND ROMAN BIOGRAPHY (3)
Study of the development of classical biography through selected works from major authors in Greek and Latin, including Xenophon, Plutarch, Nepos, and Suetonius.

16:190:614. CLASSICAL EPIC (3)
Comparative study of Homer, Apollonius, Vergil, and Lucan as epic poets.

16:190:620,621. TOPICS IN GREEK AND ROMAN ARCHAEOLOGY (3,3)
Intensive study of special Greek and Roman archaeological monuments and their significance for the literature, religion, and history of the classical civilizations.

16:190:622. LATIN EPIGRAPHY (3)
Practical introduction to the study of Latin inscriptions, with emphasis on the reading, interpretation, and editing of texts on stone.

16:190:623. LATIN PALEOGRAPHY (3)
Practical introduction to the study of Latin manuscripts from the Middle Ages and Renaissance, with emphasis on the reading, interpretation, editing, and transmission of Latin texts.

16:190:624. THE BOOK (3)
Study of the relationship between the media of publication and conventions of reading in antiquity and the literary forms of classical Greek and Latin literature.

16:190:625. ROME IN THE AGE OF AUGUSTUS (3)
Archaeological survey of urban planning; architectural and artistic achievements in Rome and the provinces seen in the broader perspective of Augustus's political and cultural program.

16:190:630. CLASSICAL GREEK SCULPTURE (3)
Stylistic and thematic discussion of the works of individual sculptors and of major monuments, such as temple pediments and friezes from 480 B.C. to the end of the fourth century.

16:190:631. ROMAN SCULPTURE (3)
The major stylistic periods of Roman sculpture in historical reliefs, sarcophagi, and portraiture from the late Republic to the age of Constantine the Great.

16:190:652. NEW COMEDY AND CHARACTER STUDY (3)
Theophrastus's *Characters* and at least two plays of Menander, with emphasis on the various kinds of characters recognized in Greek literature and their relationship to plot and dramatic action.

16:190:654. GREEK ORATORY (3)
Selected Greek public orations with emphasis on their significance in political history and their place in the development of Greek rhetoric.

16:190:655,656. ARISTOTLE (3,3)
Special philosophical problems studied in reference to Aristotle's work; emphasis on the variety of Aristotle's interests and the significance of his conceptual language.

16:190:671. LATIN SATIRE (3)
The continuity and development of satire in Greek and Latin literature. Major emphasis on the Roman satirists.

16:190:674. HELLENISTIC AND ROMAN PHILOSOPHY (3)
Major developments in ancient philosophy after Aristotle. Selected problems of philosophical significance in Stoic and Epicurean writings, with special reference to Lucretius, Cicero, and Seneca.

16:190:675. CICERO'S WORKS (3)
Selected orations, treatises, or letters of Cicero against the background of his private and public life, his sources in Greek and Roman thought, and his influence on later Western tradition.

16:190:677,678. HISTORY OF LATIN LITERATURE I: THE REPUBLIC (3,3)
The origin and development of Latin literature from its birth in the third century B.C. to the end of the Republic.

16:190:679,680. HISTORY OF LATIN LITERATURE II: THE EMPIRE (3,3)
Extensive reading in the major authors of the first and second centuries of the Roman Empire, with emphasis on the continued development of poetry and prose.

16:190:681,682. HISTORY OF GREEK LITERATURE I: ARCHAIC AND CLASSICAL (3,3)
Extensive reading in the major authors of the Archaic period; Pindar; beginnings of tragedy and comedy.

16:190:683,684. HISTORY OF GREEK LITERATURE II: CLASSICAL (CONTINUED) AND HELLENISTIC (3,3)
Extensive reading in the major authors of the classical period not covered in 16:190:681,682 and in Hellenistic literature.

16:190:701,702. RESEARCH IN CLASSICS (BA,BA)

COGNITIVE SCIENCE 185

Program Offered: **Certificate in Cognitive Science**
Director of the Certificate Program in Cognitive Science:
Professor Rochel Gelman, Rutgers Center for Cognitive Science, Psychology Building Addition, A115, Busch Campus (732/445-0638)
Web Site: *http://ruccs.rutgers.edu*

Participating Faculty

The following members and associate members of the graduate faculty, identified more fully under the subject headings indicated, are among those who participate in the certificate program in cognitive science:

Mark Baker, *Linguistics, RuCCS*
Nicholas Belkin, *Communication, Information, and Library Studies*
Ira Black, *Physiology and Neurobiology*
Alexander Borgida, *Computer Science*
Gretchen Chapman, *Psychology*
Kristin Dana, *Electrical and Computer Engineering*
Veneeta Dayal, *Linguistics*
Douglas DeCarlo, *Computer Science, RuCCS*
Viviane Deprez, *Linguistics*
Frances Egan, *Philosophy*
Jacob Feldman, *Psychology, RuCCS*
James Flanagan, *Electrical and Computer Engineering*
Jerry Fodor, *Philosophy, RuCCS*
Randy Gallistel, *Psychology, RuCCS*
Rochel Gelman, *Psychology, RuCCS*
Arnold Glass, *Psychology*
Alvin Goldman, *Philosophy, RuCCS*

Jane Grimshaw, *Linguistics, RuCCS*
Haym Hirsh, *Computer Science*
Judith Hudson, *Psychology*
Ilona Kovács, *Psychology, RuCCS*
Eileen Kowler, *Psychology, RuCCS*
Casimir Kulikowski, *Computer Science*
Ernest Lepore, *Philosophy, RuCCS*
Alan Leslie, *Psychology, RuCCS*
Michael Leyton, *Psychology*
Brian Loar, *Philosophy*
Barry Loewer, *Philosophy*
Robert Matthews, *Philosophy*
Thorne McCarty, *Computer Science, RuCCS*
Brian McLaughlin, *Philosophy*
Peter Meer, *Electrical and Computer Engineering*
Dimitris Metaxas, *Computer Science*
Thomas Papathomas, *Biomedical Engineering, RuCCS*
Alan Prince, *Linguistics, RuCCS*
Zenon Pylyshyn, *Psychology, RuCCS*
Kenneth Safir, *Linguistics*
Louis Sass, *Psychology*
Roger Schwarzschild, *Linguistics*
Manish Singh, *Psychology, RuCCS*
Eduardo Sontag, *Mathematics*
Stephen Stich, *Philosophy, RuCCS*
Matthew Stone, *Computer Science, RuCCS*
Karin Stromswold, *Psychology, RuCCS*
Bruce Tesar, *Linguistic, RuCCS*
Jerome Wakefield, *Social Work*
James Walkup, *Psychology*
Terence Wilson, *Psychology*
Robert Woolfolk, *Psychology*

Certificate Program

Cognitive science focuses on the nature and development of such abilities as perception, language, reasoning, planning, and problem solving in biological and artificial systems. This area of study is well represented at various departments at Rutgers, and the Rutgers Center for Cognitive Science (RuCCS), located on the Busch campus, helps coordinate this program. Members of the center may have joint appointments with such participating academic departments as biomedical engineering, computer science, linguistics, philosophy, and psychology, as well as with the Center for Computer Aids for Industrial Productivity, the Laboratory of Vision Research, and the School of Communication, Information and Library Studies.

The program offers students enrolled in various graduate programs a chance to carry out structured research in cognitive science with guidance from relevant faculty advisers. In addition, the program brings together students from different disciplines and provides them with a common research environment.

Students with an interest in any aspect of cognitive science may take a concentration in this area while they continue their regular studies toward a doctor of philosophy degree. Admission to the certificate program and selection of courses and research project are subject to the approval of the Cognitive Science Certificate Committee. Admission is based on academic performance and interests and requires the approval of the graduate program in which the student is enrolled.

Program Requirements

To receive the Certificate in Cognitive Science, the student must complete successfully the requirements for a Ph.D. in his or her department and meet the following additional requirements:

1. Complete 16:185:500 Proseminar in Cognitive Science.
2. Carry out a research project under the direction of a participating faculty member, normally outside the program in which the student is registered. Project proposals must be approved by the Cognitive Science Certificate Committee.
3. Take a minimum of 9 additional credits from approved courses in biomedical engineering, cognitive science, computer science, linguistics, philosophy, and psychology. At least 9 credits must be taken from outside the graduate program in which the student is registered. Courses in other related fields may be submitted by petition.

Graduate Courses

16:185:500. PROSEMINAR IN COGNITIVE SCIENCE (3)
Multidisciplinary introduction to the core areas of cognitive science. Gives students from diverse backgrounds the chance to work together. Student research interests discussed.

16:185:600,601,602,603,604. SEMINAR IN COGNITIVE SCIENCE I,II,III,IV,V (3 EACH)
Topical seminar conducted by participating faculty or visiting scholars at the Rutgers Center for Cognitive Science.

16:185:699. INDEPENDENT STUDIES IN COGNITIVE SCIENCE (BA)
May be used to meet the research project requirement for the Certificate in Cognitive Science with approval of certificate committee.
Supervised independent study.

COMMUNICATION, INFORMATION, AND LIBRARY STUDIES 194

Degree Program Offered: **Doctor of Philosophy**
Director of Graduate Program: **Professor Paul B. Kantor,**
School of Communication, Information and Library Studies, 4 Huntington Street, College Avenue Campus
(732/932-7500, ext. 8270; Fax: 732/932-6916)
Web Site: *http://scils.rutgers.edu/~phdd*

Members of the Graduate Faculty

James D. Anderson, *Professor of Library and Information Science, SCILS;*
D.L.S., Columbia
Textual database design and evaluation
Jerome Aumente, *Professor Emeritus of Journalism and Mass Media, SCILS;*
Director, Journalism Resources Institute; M.S., Columbia
Communication and information technology
Nicholas J. Belkin, *Professor of Library and Information Science, SCILS;*
Ph.D., London
Information science and technology
Ralph Blasingame, *Professor Emeritus of Library and Information Science, SCILS;*
D.L.S., Columbia
Management
Lisa Covi, *Assistant Professor of Library and Information Science, SCILS;*
Ph.D., California
Social informatics, computer-supported cooperative work, digital libraries
Mark Frank, *Associate Professor of Communication, SCILS; Ph.D., Cornell*
Expression of emotion and interpersonal deception
Gustav W. Friedrich, *Professor of Communication, SCILS; Ph.D., Kansas*
Communication theory, instructional communication, applied communication
Kathryn Greene, *Associate Professor of Communication, SCILS; Ph.D., Georgia*
Health-message design targeting; adolescent risk-taking; and disclosure of health issues
Paul B. Kantor, *Professor of Library and Information Science, SCILS;*
Ph.D., Princeton
Information and decision systems; information economics; evaluation; interfaces
James E. Katz, *Professor of Communication, SCILS; Ph.D., Rutgers*
Societal and policy implications of telecommunications and new communication technologies
Montague Kern, *Associate Professor of Journalism and Mass Media, SCILS;*
Ph.D., Johns Hopkins
Mass media and public policy; political communication
Robert W. Kubey, *Associate Professor of Communication, SCILS; Ph.D., Chicago*
Mass communication theory and effects
Carol C. Kuhlthau, *Professor of Library and Information Science, SCILS;*
Ed.D., Rutgers
Educational media; information processes
Linda C. Lederman, *Professor of Communication, SCILS; Ph.D., Rutgers*
Communication processes; communication education
Jennifer S. Mandelbaum, *Associate Professor of Communication, SCILS; Ph.D., Texas (Austin)*
Interpersonal communication; conversation analysis
Claire McInerney, *Assistant Professor of Library and Information Science, SCILS;*
Ph.D., SUNY (Albany)
Knowledge management, information ethics, virtual organizations
Hartmut B. Mokros, *Associate Professor of Communication, SCILS;*
Ph.D., Chicago
Interpersonal communication; health and communication; research methods
Susan Morgan, *Assistant Professor of Communication, SCILS; Ph.D., Arizona*
Health-communication campaigns, interpersonal communication, and intercul - tural communication

Daniel O. O'Connor, *Associate Professor of Library and Information Science, SCILS; Ph.D., Syracuse*
Research methods; library science

John V. Pavlik, *Professor of Journalism and Media Studies, SCILS; Ph.D., Minnesota*
Journalism technology and new media technologies; Spanish-language media

Ronald Rice, *Professor of Communication, SCILS; Ph.D., Stanford*
Social impacts of telecommunications, computer-mediated communication systems; network analysis; public communication campaigns

Brent D. Ruben, *Professor of Communication, SCILS; Ph.D., Iowa*
Communication theory; communication and information systems; health and medical communication

Tefko Saracevic, *Professor of Library and Information Science, SCILS; Ph.D., Case Western Reserve*
Information science; information education, management, information seeking and retrieving

William S. Solomon, *Associate Professor of Journalism and Media Studies, SCILS; Ph.D., California (Berkeley)*
Sociology of mass media; historical sociology; labor studies

Linda C. Steiner, *Associate Professor of Journalism and Media Studies, SCILS; Ph.D., Illinois (Urbana)*
Journalism history and ethics; feminist and alternative media

Lea P. Stewart, *Professor of Communication, SCILS; Ph.D., Purdue*
Organizational communication; communication and gender; communication ethics

Maureen Taylor, *Associate Professor of Communication, SCILS; Ph.D., Purdue*
Public relations, international communication, and development communication

Ross J. Todd, *Associate Professor of Library and Information Science; SCILS; Ph.D., Sydney*
Human information behavior, adolescents' information seeking and utilization, school librarianship, knowledge management

Betty J. Turock, *Professor Emerita of Library and Information Science, SCILS; Ph.D., Rutgers*
Management, information services

Kay E. Vandergrift, *Professor of Library and Information Science, SCILS; Ed.D., Columbia*
Library services for children and young adults; educational media services; distance education

Jana Varlejs, *Associate Professor of Library and Information Science, SCILS; Ph.D., Wisconsin (Madison)*
Continuing professional education; library education

Mark Winston, *Assistant Professor of Library and Information Science, SCILS; Ph.D., Pittsburgh*
Management, information services

Xiangmin Zhang, *Assistant Professor of Library and Information Science, SCILS; Ph.D., Toronto*
Interactive information retrieval; human-computer interaction

Associate Members of the Graduate Faculty

Mark Aakhus, *Assistant Professor of Communication, SCILS; Ph.D., Arizona*
Organizational communication; decision-making and disputing processes; new communication technology

Jack Z. Bratich, *Assistant Professor of Journalism and Media Studies, SCILS; Ph.D., Illinois (Urbana)*
Popular culture; social and political theory; media and democracy; technology and society

Ulla Bunz, *Assistant Professor of Communication, SCILS; Ph.D., Kansas*
Uses and effects of communication technologies; online interaction; organizational communication

Nelson L. Chou, *Librarian II, Head, East Asian Library; Ph.D., Chicago*
Library and information science

Stacey Connaughton, *Assistant Professor of Communication, SCILS; Ph.D., Texas*
Organizational communication, leadership, organizational identity, and virtual teams

Mairja Dalbello, *Assistant Professor of Library and Information Science, SCILS; Ph.D., Toronto*
Print and digital literacy, orality, print culture, textual communities, social memory

Marya L. Doerfel, *Assistant Professor of Communication, SCILS; Ph.D., SUNY (Buffalo)*
Organizational communication; organizational culture; network analysis; semantic network analysis

Jane Hannigan, *Professor Emerita, Columbia; D.L.S., Columbia*
Librarianship, youth literature and youth services, technology, distance education

Georghe Muresan, *Assistant Professor of Library and Information Science, SCILS; Ph.D., Robert Gordon (United Kingdom)*
Information retrieval

Jon L. Oliver, *Assistant Dean for Network and Information Technology, SCILS; M.S., Rutgers*
Information retrieval and dissemination in distance education

Barbara S. Reed, *Associate Professor of Journalism and Media Studies, SCILS; Ph.D., Ohio*
History and contemporary studies of ethnic press and magazines

Doug Riecken, *IBM TJ Watson Laboratories; Ph.D., Rutgers*
Human-computer interaction, information personalization, intelligent user interfaces and agents

L.J. Shrum, *Associate Professor of Marketing, RBS; Ph.D., Illinois (Urbana)*
Cognitive processes underlying media effects

Jeffrey K. Smith, *Professor of Educational Statistics and Measurement, GSE; Ph.D., Chicago*
Statistics and measurement

Anselm Spoerri, *Assistant Professor of Library and Information Science, SCILS; Ph.D., Massachusetts Institute of Technology*
Information visualization, information appliances

Nina Wacholder, *Assistant Professor of Library and Information Science, SCILS; Ph.D., CUNY*
Computational linguistics, automatic indexing, information retrieval

Itzhak Yanovitzky, *Assistant Professor of Communication, SCILS; Ph.D., Pennsylvania*
Theoretical and research design foundations, health communication, social influence, research methods

Programs

The Ph.D. program serves students who seek to acquire theoretical and research skills for scholarly activity or for leadership positions in the communication and information fields. The program focuses on the nature and functions of communications and information processes. It looks at systems, institutions, and policies and assesses their impact on individuals and organizations and upon national and international affairs. Students may focus on any of the following areas: communication processes, library and information science, or media studies.

Communication processes deals with three interrelated areas: social interaction, organizational communication, and mediated communication. Research areas include such contemporary issues as health, gender, globalization, identity, and policy. Health communication research is a major emphasis.

Library and information science concentrates on information behavior and systematic responses to it. Students opting to focus on information science learn about human information-seeking activities, information-retrieval systems, and information structures. Students whose primary interest is libraries and information centers as part of the worldwide information environment learn how to design, manage, and evaluate information systems and how to make these systems responsive to users' needs.

Media studies examines the political, social, psychological, and economic impact of the media. It describes the historical conditions that gave rise to contemporary media and covers both the traditional mass media and the new electronic technologies.

To earn a Ph.D. degree, students must complete a minimum of 36 credits of doctoral-level course work and accumulate 24 credits of dissertation research. In addition, Ph.D. candidates must have completed at least 24 credits of course work at the master's degree level.

As a part of the 36-credit course work requirement, students must take 16:194:601 Information and Communication Processes, 16:194:602 Research Foundations, 16:194:603 Qualitative Research Methods, 16:194:604 Quantitative Research Methods, and 16:194:605 Current Research Issues.

There is no language or residency requirement, and students may pursue the Ph.D. on a full- or part-time basis. Students are required to enroll for a minimum of 6 credits during each of the first two terms in the program. Teaching and research assistantships, which include tuition remission, and various fellowships are available for highly qualified full-time students.

The master of philosophy degree is also available to doctoral candidates. The School of Communication, Information and Library Studies (SCILS) offers an M.L.S. degree in library and information studies and a master of communication and information studies. These programs are described in the SCILS catalog.

Graduate Courses

16:194:600. PH.D. COLLOQUIUM (0)
Belkin. Required each term in course work. Forum for the presentation of research by guest speakers, faculty, and students.

16:194:601. INFORMATION AND COMMUNICATION PROCESSES (3)
Nature of information and communication processes, and the role of information and communication in individual, social, and institutional behavior. Particular emphasis on conceptual linkages between information and communication processes.

16:194:602. RESEARCH FOUNDATIONS (3)
Concepts, method, and practices of social science research in relation to communication, information science, and library studies.

16:194:603. QUALITATIVE RESEARCH METHODS (3)
Qualitative approaches for examining information processes, including information definition, acquisition, evaluation, and use.

16:194:604. QUANTITATIVE RESEARCH METHODS (3)
Prerequisite: 16:960:532 or 17:610:511.
Facets of research; problem areas; research techniques and experiments.

16:194:605. CURRENT RESEARCH ISSUES (3)
Prerequisites: 16:194:603 and 604.
Integrative treatment of fundamental assumptions, paradigms, and directions in contemporary research on information, communication, and information systems in various fields, particularly information science and communication.

16:194:610. SEMINAR IN INFORMATION STUDIES (3)
Major problems, trends, and developments in information science and technology. Critical survey of current research and findings.

16:194:612. HUMAN INFORMATION BEHAVIOR (3)
Prerequisite: 16:194:610 or permission of instructor.
Precursors to and characteristics of human information-seeking behavior, individual and social within and outside of institutional information systems. Relations between such behavior and information-system design and relevant technologies.

16:194:614. INFORMATION RETRIEVAL THEORY (3)
Prerequisites: 16:194:610 and 612, or permission of instructor.
Examines the basic problems of information retrieval from theoretical and experimental points of view. Develops a basis for the specification of design principles for IR systems.

16:194:617. KNOWLEDGE REPRESENTATION FOR INFORMATION RETRIEVAL (3)
Concurrent consideration of options for knowledge representation, methods for evaluating the effect of these options on costs and effectiveness, and research relating to knowledge representation for information retrieval.

16:194:619. EXPERIMENT AND EVALUATION IN INFORMATION SYSTEMS (3)
Prerequisites: 16:194:612, 614, or permission of instructor.
Measures, models, and methods for macroevaluation of impact of information systems within their environment and for microevaluation of performance of system components. Methodology and implementation strategies.

16:194:620. INTERPERSONAL COMMUNICATION (3)
Contemporary theories and major lines of classic and current research concerning interpersonal communication.

16:194:621. ORGANIZATIONAL COMMUNICATION RESEARCH (3)
Survey of major principles and research and analytic techniques related to organizational communication.

16:194:631. MASS COMMUNICATION THEORY AND RESEARCH (3)
Current mass communication theories and approaches analyzed from a research perspective. Topics include audiences, uses and gratifications, socialization processes and effects, and agenda setting.

16:194:632. SCHOLARLY AND SCIENTIFIC COMMUNICATION (3)
Study of the processes through which scholarly, scientific, and technical ideas are communicated: mentoring; professional, national, and international information networks; scholarly and scientific publishing; examines other aspects of specialized information transfer.

16:194:641. INFORMATION POLICY AND TECHNOLOGY (3)
Impact of modern revolution in information technology; related challenges of contemporary problems in information policies at individual, organizational, national, and international levels. Use of information indicators.

16:194:642. INFORMATION REGULATION AND LAW (3)
Historical and contemporary legal and regulatory issues stemming from the application of information technology.

16:194:643. INFORMATION INDICATORS (3)
Integrated treatment of measures, indicators, and methods for quantitative description of information and communication systems, resources, and activities. Emphasis on drawing relations among different measures and application to information policy studies.

16:194:645. ADVANCED CONCEPTS IN THE MANAGEMENT OF INFORMATION ORGANIZATIONS (3)
Prerequisite: 17:610:570 or equivalent.
Systematic consideration of the evolution of management theory leading to an evaluation of contemporary theoretical and research issues in planning, organizing, staffing, leading, and controlling the information organization.

16:194:648. ORGANIZATIONAL ASSESSMENT AND CHANGE (3)
Offered in alternate years.
Systematic consideration of the theories and strategies of assessment, planning, development, and change at the organizational and programmatic levels in nonprofit and profit-seeking information organizations.

16:194:656. THEORIES AND ISSUES IN LIBRARY STUDIES (3)
Examination of the intellectual foundations for librarianship as a discipline, the development of a broadened understanding of pervasive theories and research issues, and the identification and exploration of research literature in librarianship and pertinent allied fields.

16:194:660. AUDIENCE STUDIES (3)
The nature of audiences, how audiences emerge, and how audiences can be studied. Weak/strong effects, uses and gratifications, reader response theory, cultural studies.

16:194:662. MEDIA LITERACY (3)
Theories of media education and approaches to media pedagogy.

16:194:663. MEDIA HISTORY AND INSTITUTIONS (3)
The history of print and electronic media, emphasizing the media's political economy, the interrelationship of media and society, and the ideological component in writing history.

16:194:664. MEDIA AND CULTURE (3)
Cultural approaches to media studies. Topics include cultural theory; aesthetics and taste; representation and ideology; consumer culture; media, culture, and identity; gender, race, class, and sexuality in media; fandom and subcultures.

16:194:665. MEDIA AND POLITICS (3)
Theories and research relating old and new media to political decision making. Topics include public attitudes and opinion, media policy, interest articulation, political culture, ideology, rhetoric and content analysis, framing, agenda-setting.

16:194:666. SOCIAL CONSTRUCTION OF NEWS (3)
Social science research on news and the news media; diverse scholarly perspectives, comparing them with the views of journalists, journalism critics, and the public.

16:194:695. TEACHING APPRENTICESHIP (0)
Prerequisite: 9 credits in Ph.D. program.
A noncredit teaching apprenticeship to provide doctoral candidates with classroom experience.

16:194:696,697. SPECIAL TOPICS (3,3)
Possible topics include communication technology and policy; naturalistic inquiry; human/computer interaction; history of U.S. mass media; intercultural communication; and race, gender, and the media.

16:194:698. INDEPENDENT STUDY (3)

16:194:699. INDEPENDENT STUDY (3)

16:194:701,702. DISSERTATION RESEARCH (BA,BA)

COMMUNICATION STUDIES
(See the catalog of the School of Communication, Information and Library Studies for information about programs leading to the master of communication and information studies.)

COMPARATIVELITERATURE 195

Degree Programs Offered: **Master of Arts, Doctor of Philosophy**
Director of Graduate Program: **Professor Janet A. Walker,**
  205 Ruth Adams Building, Douglass Campus (732/932-7606)

Members of the Graduate Faculty

Derek Attridge, *Distinguished Visiting Professor of English, FAS–NB; Ph.D., Cambridge*
  Literary theory; literary language; poetic form; James Joyce
César A. Braga-Pinto, *AssistantProfessor of Portuguese, FAS–NB; Ph.D., California (Berkeley)*
  Twentieth-century Brazilian and Portuguese literature; Brazilian popular music and cultural studies; postcolonialism
Stephen Bronner, *Professor of Political Science, FAS–NB; Ph.D., California (Berkeley)*
  Critical theory; political theory
Abena P.A. Busia, *Associate Professor of English, FAS–NB; D.Phil., Oxford*
  African women in British and American fiction
Ed Cohen, *Associate Professor of English, FAS–NB; Ph.D., Stanford*
  Cultural studies; gender studies
Drucilla Cornell, *Professor of Law and Women's Studies, SL–N and FAS–NB; J.D., California Law School (Los Angeles)*
  Feminist theory; aesthetics
Harriet A. Davidson, *Associate Professor of English, FAS–NB; Ph.D., Vanderbilt*
  Modern and contemporary poetry; modern British and American literature; critical theory
Marianne DeKoven, *Professor of English, FAS–NB; Ph.D., Stanford*
  Modernism; women's studies
Elin F. Diamond, *Professor of English, FAS–NB; Ph.D., California (Davis)*
  Drama and dramatic theory; feminist and literary theory
Josephine Diamond, *Professor of French, FAS–NB; Ph.D., Cornell*
  Nineteenth- and 20th-century literature; critical theory; women's studies and feminist theory
William C. Donahue, *AssociateProfessor of German, FAS–NB; Ph.D., Harvard*
  Nineteenth- and 20th-century literature; German-Jewish studies
Lowell Edmunds, *Professor of Classics, FAS–NB; Ph.D., Harvard*
  Greek literature, mythology, intellectual history
Uri A. Eisenzweig, *Professor of French, FAS–NB; Ph.D., Paris*
  French literature; literary theory; Western literature of the 19th and 20th centuries
Jerry Aline Flieger, *Professor of French, FAS–NB; Ph.D., California (Berkeley)*
  Twentieth-century literature; critical theory; women's studies and feminist theory

Sandy Flitterman-Lewis, *Associate Professor of English, FAS–NB; Ph.D., California (Berkeley)*
  Feminist cultural analysis with an emphasis on film and literature
William Galperin, *Professor of English, FAS–NB; Ph.D., Brown*
  Romantic literature; literary theory; media studies
Mary S. Gossy, *Associate Professor of Spanish, FAS–NB; Ph.D., Harvard*
  Spanish and Latin American literature; feminist and critical theory; lesbian and gay studies
Myra Jehlen, *Board of Governors Professor of Literature and Culture, FAS–NB; Ph.D., California (Berkeley)*
  American literature; feminist criticism; cultural history
Jorge Marcone, *Associate Professor of Spanish, FAS–NB; Ph.D., Texas*
  Contemporary Spanish-American literature; literacy and orality; regionalism; critical theory
Michael McKeon, *Board of Governors Professor of English, FAS–NB; Ph.D., Columbia*
  Seventeenth- and 18th-century literature; critical theory; historical criticism
Alicia Ostriker, *Professor of English, FAS–NB; Ph.D., Wisconsin*
  Romantic and modern literature; contemporary poetry
Gerald Pirog, *Associate Professor of Slavic Languages and Literatures, FAS–NB; Ph.D., Yale*
  Slavic languages and literatures; critical theory; poetry
Nicholas Rennie, *Assistant Professor of German, FAS–NB; Ph.D., Yale*
  Eighteenth- to 20th-century aesthetics; age of Goethe; critical theory; German intellectual history
Louis Sass, *Professor of Clinical Psychology, GSAPP; Ph.D., California (Berkeley)*
  Literature and psychology; hermeneutics
Paul Schalow, *Associate Professor of Japanese, FAS–NB; Ph.D., Harvard*
  Japanese literature (Edo period); gender and sexuality in Japanese literature; Japanese women's writing
Louisa Schein, *Associate Professor of Anthropology, FAS–NB; Ph.D., California (Berkeley)*
  China; cultural studies
Richard Serrano, *Assistant Professor of French and Comparative Literature, FAS–NB; Ph.D., California (Berkeley)*
  Francophone, classical Arabic and classical Chinese literatures, lyric poetry
Ben Sifuentes-Jáuregui, *Associate Professor of Spanish, FAS–NB; Ph.D., Yale*
  Twentieth-century Latin American literature and cultural studies; gender and queer theory; psychoanalysis; postcolonial criticism
Mary Speer, *Professor of French, FAS–NB; Ph.D., Princeton*
  Medieval language and literature; theory and practice of editing
James Swenson, *Associate Professor of French, FAS–NB; Ph.D., Yale*
  Eighteenth-century literature, critical theory
Ching-I Tu, *Professor of Chinese, FAS–NB; Ph.D., Washington*
  Chinese studies; poetry and literary criticism
Alessandro Vettori, *Assistant Professor of Italian, FAS–NB; Dott. in Lettere, Florence; Ph.D., Yale*
  Thirteenth-century literature; Dante and Franciscan literature
Janet A. Walker, *Professor of Comparative Literature, FAS–NB; Ph.D., Harvard*
  The novel; comparative Asian and Western modernities
Steven F. Walker, *Professor of Comparative Literature, FAS–NB; Ph.D., Harvard*
  Renaissance, literature and mythology; Jungian criticism
Ban Wang, *Associate Professor of Chinese, FAS–NB; Ph.D., California (Los Angeles)*
  Cultural and cinema studies; modern Chinese literature; aesthetics
Andrew Welsh, *Associate Professor of English, FAS–NB; Ph.D., Pittsburgh*
  Old English and medieval studies; poetry
Alan Williams, *Professor of French, FAS–NB; Ph.D., SUNY (Buffalo)*
  Film history and theory; literary theory; contemporary French literature
Yael Zerubavel, *Professor of History, FAS–NB, and Director of the Center for the Study of Jewish Life; Ph.D., Pennsylvania*
  Jewish studies; folklore

Programs

The graduate program in comparative literature enables students to pursue literary studies across national, linguistic, cultural, and disciplinary boundaries. Areas of study include genres, periods, movements, East-West poetics, colonial and postcolonial literatures, and minority and marginalized literatures. In addition, students can explore such issues as literature and gender and the interaction of literature with other fields.

The program draws upon a distinguished and diverse faculty from several disciplines. It seeks to combine the rigor of a structured curriculum with flexibility to meet the needs of individual students. Each student arranges his or her program in consultation with the graduate director and an adviser. Students may take as many as 50 percent of their courses from other departments. The program participates in the Transliteratures program (q.u.).

Candidates for the M.A. degree must complete 30 credits of course work and pass two foreign language examinations. In addition, they must pass two written examinations, one on theory and a second on a genre studied within a century or a limited period.

Candidates for the Ph.D. degree must complete 48 credits of course work and 24 research credits. After they have completed 12 credits at Rutgers, students entering the program with an M.A. degree from another university may apply to transfer as many as 24 credits. They will need permission of the graduate director and the graduate dean, however, to complete the transfer. In addition, candidates must pass three foreign language examinations and the two written examinations mentioned above. There also are three oral examinations. One deals with a second genre studied over at least three centuries, a second covers a literary movement, and the third focuses on a topic related to the dissertation. The degree will be conferred after successful defense of the dissertation.

Applications requesting consideration for fellowship grants should be submitted before February 1. The *Guide for Graduate Students in Comparative Literature* is available in the program office.

Graduate Courses

16:195:501. INTRODUCTION TO LITERARY THEORY (3)
Introduction to contemporary literary theory, including formalism, structuralism, poststructuralsim, feminism, psychoanalysis, cultural studies, and other approaches. Readings of theoretical texts and applications to short literary texts from a variety of literatures.

16:195:502. WOMEN AND WRITING (3)
Social, aesthetic, and theoretical issues of women and writing through representative writers, movements, texts, and contexts.

16:195:503. POETRY IN TRANSLATION (3)
Study of translation as creative interpretation, with emphasis on Greco-Roman classics. Readings may include works by Euripides, Homer, Aristophanes, and others.

16:195:505,506. STUDIES IN MEDIEVAL LITERATURE (3,3)
Basic English and continental texts, with emphasis on relationships with modern literature.

16:195:507,508. PROVENÇAL LANGUAGE AND LITERATURE (3,3)
Introduction to Old Provençal, with readings in major troubadours, and tracing of troubadour influences on the early lyrics of Western Europe.

16:195:509. STUDIES IN THE RENAISSANCE (3)
Survey of intellectual currents and study of representative works, including epic, lyric, prose fiction, and drama; analysis of stylistic changes from the early to the late Renaissance.

16:195:511. STUDIES IN THE NEOCLASSICAL PERIOD (3)
Late 16th- and 17th-century development of neoclassical intellectual, artistic, and literary doctrines, stressing the Italian baroque origins of the movement, its French development, and its English repercussions.

16:195:512. THE ENLIGHTENMENT (3)
Major authors studied with emphasis on literary and aesthetic concerns and their link to the philosophical.

16:195:513. ROMANTICISM (3)
European romanticism as a literary movement, emphasizing the genres of the lyric, the novel, and the drama.

16:195:514. SYMBOLISM (3)
English, German, and American roots of French symbolism; its influence on such figures as Ruben Dario and A. Blok.

16:195:515. STUDIES IN CONTEMPORARY LITERATURE (3)
Assessment of major trends in today's literature, with equal attention paid to the traditions they question and the evolving society they illustrate.

16:195:516. TOPICS IN COMPARATIVE LITERATURE (3)

16:195:517,518. INDIVIDUAL STUDIES IN COMPARATIVE LITERATURE (3,3)
Directed readings and frequent written analyses.

16:195:519. TOPICS IN COMPARATIVE LITERATURE AND OTHER FIELDS (3)

16:195:521. TOPICS IN NON-WESTERN LITERATURE (3)

16:195:601. THE NOVEL (3)
Generic and thematic study of the novel as it evolved in Europe and the Western world in general. Some attention to the non-Western novel.

16:195:602. POETRY (3)
Studies in poetic genres.

16:195:603. DRAMA (3)
Studies in dramatic genres.

16:195:604. STUDIES IN NARRATIVE (3)
Studies in narrative genres.

16:195:605. MAJOR AUTHORS (3)
Close study, in a comparative context, of the works of one or more major authors.

16:195:606. THEORY AND PRACTICE OF TRANSLATION (3)
Consideration of various approaches to a common text, with attempts at creative practice.

16:195:607. STUDIES IN NONFICTIONAL PROSE (3)
From historical to scientific, to legal texts; from biography to autobiography, to private correspondence. The rhetoric and form of nonfictional prose and its relation to literature.

16:195:608. ADVANCED TOPICS IN COMPARATIVE LITERATURE (3)

16:195:609. COMPARATIVE LITERATURE AND OTHER FIELDS (3)
Relationships between literature and such fields as art, history, anthropology, philosophy, and music.

16:195:611. PSYCHOANALYTIC APPROACHES TO LITERATURE (3)
Function of literature viewed from a psychoanalytic perspective; the (psycho)analysis of the literary text; approaches to the biography of the artist; literary responses to modern psychoanalysis.

16:195:612. LITERATURE AND THE SOCIAL ORDER (3)
Society in the text; literary texts in society. Political and ideological aspects of a complex interaction.

16:195:613. MINORITY LITERATURES (3)
Literary texts written and read by minority groups in various contexts. The social, philosophical, and aesthetic implications of the very notion of minority literature.

16:195:614. COMPARATIVE EAST-WEST POETICS (3)
Comparison of the literary systems of the Eastern and Western worlds, including conceptions of literature, literary genres, and critical terminology.

16:195:615. EAST-WEST LITERARY RELATIONS (3)
Literary works of Eastern and Western worlds studied in the comparative context of actual historical meetings.

16:195:617. TOPICS IN ADVANCED LITERARY THEORY (3)

16:195:621. ADVANCED TOPICS IN NON-WESTERN LITERATURE (3)

16:195:701,702. RESEARCH IN COMPARATIVE LITERATURE (BA,BA)

COMPUTER SCIENCE 198

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Martin Farach-Colton,**
  H442 Hill Center, Busch Campus (732/445-3629)

Members of the Graduate Faculty

Eric Allender, *Professor of Computer Science, FAS–NB; Ph.D., Georgia Institute of Technology*
  Complexity theory; parallel and probabilistic computation
Ricardo Bianchini, *Assistant Professor of Computer Science, FAS–NB; Ph.D., Rochester*
  Parallel and distributed systems; operating systems and architecture
Alexander Borgida, *Professor of Computer Science, FAS–NB; Ph.D., Toronto*
  Artificial intelligence in the design of information systems
Vašek Chvátal, *Professor of Computer Science, FAS–NB; Ph.D., Waterloo*
  Algorithms; combinatorics; graph theory; operations research
Douglas DeCarlo, *Assistant Professor of Computer Science, FAS–NB/RuCCS; Ph.D., Pennsylvania*
  Computer graphics, computer vision, human-computer interaction
Stanley Dunn, *Professor of Biomedical Engineering, SE; Ph.D., Maryland*
  Computer vision; image understanding; pattern recognition
Ahmed Elgammal, *Assistant Professor of Computer Science, FAS–NB; Ph.D., Maryland*
  Computer vision; multimedia
Martin Farach-Colton, *Associate Professor of Computer Science, FAS–NB; M.D., Johns Hopkins; Ph.D., Maryland*
  Computational biology; design and analysis of algorithms
Michael L. Fredman, *Professor of Computer Science, FAS–NB; Ph.D., Stanford*
  Data structures and algorithms; computational complexity
Apostolos Gerasoulis, *Professor of Computer Science, FAS–NB; Ph.D., SUNY (Stony Brook)*
  Parallel processing; algorithms; numerical analysis
Michael D. Grigoriadis, *Professor of Computer Science, FAS–NB; Ph.D., Wisconsin*
  Mathematical programming; algorithms; structured and network optimization
Peter Hammer, *Professor of Mathematics and Operations Research, FAS–NB; Ph.D., Bucharest*
  Boolean methods in operations research; discrete optimization
Haym Hirsh, *Chairperson and Professor of Computer Science, FAS–NB; Ph.D., Stanford*
  Artificial intelligence; machine learning
Liviu Iftode, *Associate Professor of Computer Science, FAS–NB; Ph.D., Princeton*
  Distributed and parallel systems; operating systems; mobile computing
Tomasz Imielinski, *Division Director and Professor of Computer Science, FAS–NB; Ph.D., Polish Academy of Sciences*
  Mobile wireless computing; data mining
Daniel Jiménez, *Assistant Professor of Computer Science, FAS–NB; Ph.D., Texas*
  Computer architecture
Jeffry Kahn, *Professor of Mathematics, FAS–NB; Ph.D., Ohio State*
  Combinatorics
Bahman Kalantari, *Associate Professor of Computer Science, FAS–NB; Ph.D., Minnesota*
  Mathematical programming; matrix scaling; duality theory; approximation algorithms; approximation of π; polynomial root-finding
Leonid Khachiyan, *Professor of Computer Science, FAS–NB; D.Sc., USSR Academy of Sciences*
  Mathematical programming; complexity; discrete optimization
Janos Komlos, *Professor of Mathematics, FAS–NB; Ph.D., Eotvos*
  Combinatorics; probability; theoretical computer science
Ulrich Kremer, *Assistant Professor of Computer Science, FAS–NB; Ph.D., Rice*
  Compilers for parallel machines; compiler-directed power and energy management
S. Mutha Krishnan, *Assistant Professor of Computer Science, FAS–NB; Ph.D., New York*
  Algorithm design; databases; data compression; computational biology
Casimir Kulikowski, *Board of Governors Professor of Computer Science, FAS–NB; Ph.D., Hawaii*
  Artificial intelligence; pattern recognition; imaging; biomedical applications
Saul Y. Levy, *Associate Professor of Computer Science, FAS–NB; Ph.D., Yeshiva*
  Massively parallel architectures; algorithms
Michael Littman, *Associate Professor of Computer Science, FAS–NB; Ph.D., Brown*
  Machine learning; planning; artificial intelligence
David Madigan, *Professor of Statistics, FAS–NB; Ph.D., Trinity (Dublin)*
  Data mining; statistical computing
Richard Martin, *Assistant Professor of Computer Science, FAS–NB; Ph.D., California (Berkeley)*
  High-performance network design and evaluation; parallel architecture and languages; high throughput I/O systems

L. Thorne McCarty, *Professor of Computer Science and Law, FAS–NB/SL–N; J.D., Harvard*
  Artificial intelligence; knowledge representation; logic programming; legal reasoning
Peter Meer, *Associate Professor of Electrical and Computer Engineering, SE; D.Sc., Technion (Israel)*
  Computer vision; image processing; pattern recognition
Dimitris Metaxas, *Professor of Computer Science, FAS–NB; Ph.D., Toronto*
  Physics-based modeling; computer graphics and animation; computational vision; medical imaging
Evangelia Micheli-Tzanakou, *Professor of Biomedical Engineering, SE; Ph.D., Syracuse*
  Visual pattern recognition; neural networks; neural computing
Naftaly H. Minsky, *Professor of Computer Science, FAS–NB; Ph.D., Hebrew (Jerusalem)*
  Distributed computing; electronic commerce; security; software engineering
Badri Nath, *Professor of Computer Science, FAS–NB; Ph.D., Massachusetts*
  Mobile wireless computing; network services; sensor networks
Thu Nguyen, *Assistant Professor of Computer Science, FAS–NB; Ph.D., Washington*
  Pervasive, highly available, and secure distributed computing; networking
Dinesh Pai, *Professor of Computer Science, FAS–NB; Ph.D., Cornell*
  Multisensory computation; simulation; modeling
Marvin C. Paull, *Professor of Computer Science, FAS–NB; B.S., Clarkson*
  Computer structures; principles and practice
Vladimir Pavlovic, *Assistant Professor of Computer Science, FAS–NB; Ph.D., Illinois*
  Bioinformatics; machine learning; neural computation; computer vision
Gerard R. Richter, *Professor of Computer Science, FAS–NB; Ph.D., Harvard*
  Numerical solutions of differential and integral equations
Barbara Ryder, *Professor of Computer Science, FAS–NB; Ph.D., Rutgers*
  Programming languages; software engineering; parallel and distributed computing
Michael Saks, *Professor of Mathematics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
  Combinatorics; complexity theory; algorithms
Charles F. Schmidt, *Professor of Psychology, FAS–NB; Ph.D., Iowa*
  Artificial intelligence; belief systems; inference; cognition
Eduardo Sontag, *Professor of Mathematics, FAS–NB; Ph.D., Florida*
  Nonlinear control; neural networks
William L. Steiger, *Professor of Computer Science, FAS–NB; Ph.D., Australian National*
  Algorithms; parallel computations; computational geometry
Louis Steinberg, *Associate Professor of Computer Science, FAS–NB; Ph.D., Stanford*
  Artificial intelligence; knowledge-based design; VLSI; machine learning
Matthew Stone, *Assistant Professor of Computer Science, FAS–NB/RuCCS; Ph.D., Pennsylvania*
  Natural language generation, conversational dialogue agents, knowledge representation and logic programming
Mario Szegedy, *Professor of Computer Science, FAS–NB; Ph.D., Chicago*
  Complexity theory; PCP theory, combinatorics, geometry, algebra
Endre Szemerédi, *State of New Jersey Professor of Computer Science, FAS–NB; Sc.D., Moscow*
  Number theory; extremal graphs; theoretical computer science
Robert Vichnevetsky, *Professor of Computer Science, FAS–NB; Ph.D., Brussels*
  Numerical analysis; simulation of systems; computational fluid dynamics

Associate Members of the Graduate Faculty

Charles L. Hedrick, *Director, New Brunswick Computing Services, FAS–NB; Ph.D., Carnegie Mellon*
  Networking; distributed computing environments
Donald E. Smith, *Associate Research Professor of Computer Science, FAS–NB; Ph.D., Rutgers*
  Object-oriented languages; AI for design optimization; intelligent tutoring systems

Programs

The program in computer science offers courses in most areas of the field and provides flexible options for advanced research. To enter the program, applicants must have completed an accredited undergraduate program in computer science or at least taken the core courses required for an undergraduate degree in computer science. This includes a substantial background in mathematics, especially calculus, linear algebra, discrete mathematics, and probability/combinatorics. Students should have at least one term in all of these subjects and two terms in calculus. Finally, applicants should have taken high-level languages, data structures, assembly language and machine organization, algorithm design and analysis, and an advanced undergraduate-level elective course. All

applicants are required to take the Graduate Record Examination's general and computer science examinations.

Candidates for an M.S. degree have two options. They may complete 30 credits of course work and write an acceptable expository essay, or they may take 24 credits of course work and submit a master's thesis worth 6 credits. The candidate also must pass the program's master examination, which is designed to ensure breadth of knowledge. Courses are offered to help students prepare for the examination.

A candidate for the Ph.D. degree must complete 48 hours of course work beyond the bachelor's degree. Students who enter the program after earning a master's degree may apply to transfer 24 of the 48 credits required for the lower degree. Normally, the program requires one year in residence, but in special cases the department will consider alternatives to full-time residence. In addition, the student must pass a qualifying examination before beginning his or her thesis research, which forms a major part of the Ph.D. program (24 credits). The thesis should cover original investigations in one or more problems in computer science. A master of philosophy degree is available to doctoral candidates.

Current research being done by the graduate faculty is expected to stimulate doctoral research. Faculty research interests include algorithms, artificial intelligence, combinatorics, complexity theory, computational biology, computational geometry, computational linguistics, data structures, distributed systems, graphics, human-computer interaction, information systems, knowledge representation, machine learning, mathematical programming, and mobile computing. Faculty members also are exploring numerical analysis, networking, optimization, parallel computing and systems, programming languages and compilers, software engineering, and vision. All qualified graduate students are eligible to be considered for teaching assistantships and fellowships. Also, several grant-supported research projects have research assistantships for advanced graduate students.

Several coupled computing environments supporting faculty, graduate students, and undergraduates are accessible from a variety of desktop workstations (Sun, DEC, NCR, Dell, Apple). These environments provide cycle and file service using multiuser servers (Sun, SGI, PC) over high-speed networks that support shared printers and modems. All faculty and graduate student offices are equipped with networked workstations connected to servers that support large-memory and massive parallel computing. In addition, dedicated research and instructional laboratories are available. Students, for example, have access to electronic laboratories and classrooms, clusters of PC servers, and two 64-processor Sun Enterprise 10,000 units. The department's computer facilities are run by the staff of the Laboratory for Computer Science Research.

All facilities are located in the CoRE (Computer Research and Engineering) Building, which also houses the Center for Discrete Mathematics and Theoretical Computer Science (DIMACS), and in the Hill Center for the Mathematical Sciences, which also houses the Library of Mathematical Sciences.

Further information may be found in the *Graduate Program in Computer Science,* a brochure available from the program and on the web at *http://www.cs.rutgers.edu.*

Graduate Courses

16:198:500. PROSEMINAR IN COMPUTER SCIENCE (1)
Required for all new full-time students in Ph.D. program.
Several sections are offered each term, introducing students to research activities inside the department. Format varies.

16:198:505. COMPUTER STRUCTURES (3)
Levy, Paull. Prerequisite: Admission requirements.
Hardware subsystems. Computer organization, memory systems, arithmetic, I/O, control, data communications, parallel processors, RISC architectures, and other topics of current interest.

16:198:507. (F) ADVANCED COMPUTER ARCHITECTURE (3)
Bianchini, Iftode, Martin, Nguyen. Prerequisite: 16:198:505.
Advanced topics in computer architecture, including advanced processor design, models and workload characteristics for multiprocessor systems, memory and cache coherence and consistency, multiprocessor architecture, and I/O.

16:198:509. (F) FOUNDATIONS OF COMPUTER SCIENCE (3)
Allender, Szegedy. Prerequisite: Admission requirements.
Introduction to first-order logic, emphasizing methods used in computer science. Introduction to mathematical models of computation, especially deterministic and nondeterministic Turing machines, computability theory, and space and time complexity theory. P and NP.

16:198:510. NUMERICAL ANALYSIS (3)
Gerasoulis, Richter, Vichnevetsky. Prerequisites: Ability to program; a minimum of four terms of undergraduate mathematics, including calculus and linear algebra.
Derivation, analysis, and application of methods used to solve numerical problems with computers; solution of equations by iteration, approximation of functions, differentiation and quadrature, differential equations, linear equations and matrices, least squares.

16:198:513. DESIGN AND ANALYSIS OF DATA STRUCTURES AND ALGORITHMS I (3)
Chvátal, Farach-Colton, Fredman, Kalantari, Khachiyan, Steiger, Szemerédi. Prerequisites: Admission requirements; familiarity with Prim and Kruskal minimum spanning tree algorithms and Dijkstra shortest path algorithm.
Worst case, average case, and amortized analysis. Data structures: search trees, hash tables, heaps, Fibonacci heaps, union-find. Algorithms: string matching, sorting and ordering statistics, graph algorithms. NP-completeness.

16:198:514. (S) DESIGN AND ANALYSIS OF DATA STRUCTURES AND ALGORITHMS II (3)
Chvátal, Fredman, Khachiyan, Steiger. Prerequisite: 16:198:513.
Advanced data structures, approximation algorithms, probabilistic and randomized algorithms, number-theoretic algorithms, and parallel computation.

16:198:515. (F) PROGRAMMING LANGUAGES AND COMPILERS I (3)
Borgida, Kremer, Ryder. Prerequisites: A first course in compilers (equivalent to 01:198:415) and 16:198:513 (both are possible corequisites with permission of instructor).
LR parsing; attributed grammars; code generation; types and polymorphism; programming language paradigms: logic, functional, object-oriented; data abstraction; formal semantics: axiomatic l-calculus, denotational.

16:198:516. (S) PROGRAMMING LANGUAGES AND COMPILERS II (3)
Kremer, Ryder. Prerequisite: 16:198:515.
Advanced topics in compiler design and modern programming language paradigms chosen from optimization, especially register allocation methods; data flow analysis techniques, including interprocedural analysis; parallelization of sequential programs; incremental compilation.

16:198:519. OPERATING SYSTEMS THEORY (3)
Bianchini, Iftode, Martin, Nath, Nguyen. Prerequisite: 01:198:416 or 16:198:505 or equivalent.
Operating system basics; process management; synchronization, memory management; interprocess communication, network protocols, RPC, client-server architectures; file systems and distributed file systems; scheduling and security; current trends and case studies.

16:198:520. INTRODUCTION TO ARTIFICIAL INTELLIGENCE (3)
DeCarlo, Hirsh, Kulikowski, McCarty, Steinberg, Stone. Prerequisite: Admission requirements.
Overview of artificial intelligence. Basic problems and methods; deductive inference, declarative programming, heuristic search; reasoning and representation in perception, planning, and learning.

16:198:521. LINEAR PROGRAMMING (3)
Chvátal, Grigoriadis, Kalantari, Khachiyan. Prerequisites: Linear algebra and admission requirements.
Linear inequalities, extreme points and rays, fundamental theorems. Optimality and duality. Geometric view. Primal and dual simplex methods. Degeneracy. Primal-dual method. Sensitivity. Basis factorization, implementation issues. Column generation. Structured models. Network simplex method and unimodularity. Polynomial-time algorithms for linear programming.

16:198:522. (S) NETWORK AND COMBINATORIAL OPTIMIZATION ALGORITHMS (3)
Grigoriadis. Prerequisites: 16:198:503 or 513 or equivalent, elementary knowledge of linear programming, or permission of instructor.
Negative and minimum mean cycles. Maximum flows and minimum cuts. Combinatorial implications. Dynamic trees and scaling. Parametric flows. Minimum cost-flow networks. Generalized, multiterminal, and multicommodity flows. Sparsest cuts. Nonbipartite cardinality and weighted matching. T-joins. Spanning trees and matroids. Approximation algorithms.

16:198:523. (F) COMPUTER GRAPHICS (3)
DeCarlo. Prerequisites: 01:198:323, 344, 16:198:510, or 513; fluency in C or C++ .
Introduction to computer image synthesis: modeling, animation, rendering, and geometric techniques. Topics include geometric transformations, modeling hierarchies, viewing and visibility, animation techniques, curve and surface design, lighting, shading, and ray tracing.

16:198:524. (S) NONLINEAR PROGRAMMING ALGORITHMS (3)
Kalantari. Prerequisites: 16:198:521 or equivalent, four terms of calculus.
Convex sets and functions. Unconstrained and constrained optimization. First- and second-order optimality conditions. Duality theory. Conjugate and quasi-Newton methods. Line search and feasible direction methods. Quadratic programming, linear complementarity. Approaches to global optimization. Karmarkar's algorithm. Path-following Newton methods. Matrix scaling.

16:198:525,526. ADVANCED NUMERICAL ANALYSIS (3,3)
Richter, Vichnevetsky. Prerequisite: 16:198:510 or equivalent.
In-depth analysis of selected topics from the following: linear algebraic systems; computation of eigenvalues and eigenvectors; numerical solution of initial- and boundary-value problems for ordinary differential equations; spline and Fourier approximation.

16:198:527. (S) COMPUTER METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS (3)
Richter, Vichnevetsky. Prerequisites: Background in numerical analysis, computer programming, and elementary theory of partial differential equations.
Principles of advanced numerical analysis and computer programming for the solution of partial differential equations. Introduction to finite element methods. Theory of stability and accuracy of methods for hyperbolic, parabolic, and elliptic problems. Emphasis on applications in science and engineering.

16:198:528. (S) PARALLEL NUMERICAL COMPUTING (3)
Gerasoulis. Prerequisites: Numerical algorithms (01:198:323 or 16:198:510) and nonnumerical algorithms (01:198:344 or 16:198:503); basics of Unix, Fortran, or C.
Analysis of numerical algorithms for a variety of parallel architectures. Parallelization of existing algorithms. Mapping of algorithms onto various architectures. Techniques for developing fast parallel numerical algorithms. Algorithms implemented on existing simulators or actual parallel machines.

16:198:529. (F) COMPUTATIONAL GEOMETRY (3)
Szegedy or Steiger. Prerequisite: 16:198:513. Recommended: 16:198:514.
Design and analysis of algorithms for geometric problems. Topics include proof of lower bounds, convex hulls, searching and point location, plane sweep and arrangements of lines, Voronoi diagrams, intersection problems, decomposition and partitioning, farthest-pairs and closest-pairs, curved and rectilinear geometry.

16:198:530. (F) PRINCIPLES OF ARTIFICIAL INTELLIGENCE (3)
DeCarlo, Hirsh, Kulikowski, McCarty, Steinberg, Stone. Prerequisite: 01:198:440 or permission of instructor.
Introduction to current research problems and methods in artificial intelligence. Models of real-world tasks, including uncertainty, reward, and causality; model-based reasoning for perception and action. Overview of current research applications.

16:198:531. (F) ARTIFICIAL INTELLIGENCE SOFTWARE: TECHNIQUES AND LANGUAGES (3)
Steinberg. Prerequisite: 16:198:520.
Programming tools needed to write or understand AI systems. Search, pattern matching, LISP, logic programming, objects and frames, rules.

16:198:532. (S) FOUNDATIONS OF KNOWLEDGE REPRESENTATION (3)
Borgida, McCarty. Prerequisites: 16:198:509, 520, or permission of instructor.
Knowledge-representation problem in AI, with an emphasis on the use of logical techniques. Computational logic. Modal logics of time, action, knowledge, belief. Formal analysis of reasoning that is not strictly deductive (e.g., nonmonotonic reasoning, abductive reasoning). Approaches to tractable reasoning.

16:198:533. (S) NATURAL LANGUAGE PROCESSING (3)
Stone. Prerequisite: 16:198:530 or permission of instructor.
Survey of models and reasoning required in computational systems that use natural language to communicate. Linguistic description and computational models of syntax, semantics, discourse, and conversation. Algorithms for parsing, generation, dialogue management, and collaboration.

16:198:534. (S) COMPUTER VISION (3)
DeCarlo. Prerequisite: 16:198:530 or permission of instructor.
Provides an understanding of processes involved in formation of images of visual scenes; examines how computational approaches for transforming, estimating, or recognizing such images are formulated and implemented. Course also looks at where these methods can and have been applied. Stresses implementation and practical use of a wide variety of vision algorithms.

16:198:535. (S) PATTERN RECOGNITION THEORY AND APPLICATIONS (3)
Kulikowski. Prerequisite: 16:198:530.
Pattern recognition as an inductive process, statistical classification, parametric and nonparametric methods, adaptive methods, error estimation, applications in image processing, character, speech recognition, and diagnostic decision making.

16:198:536. (S) MACHINE LEARNING (3)
Hirsh. Prerequisite: 16:198:530 or permission of instructor.
Survey of machine learning, including decision-tree and rule learning systems, neural networks, Bayesian approaches, nearest neighbor methods, PAC-learning, genetic algorithms, reinforcement learning, and inductive logic programming.

16:198:538. (S) COMPLEXITY OF COMPUTATION (3)
Allender. Prerequisites: 16:198:509, 513.
Complexity classes, reducibilities, and complete sets. Relationships between time and space complexity, between serial and parallel computation, and among deterministic, probabilistic, and nondeterministic computation. Complexity theoretic notions of randomness.

16:198:539. (F) THEORY OF COMPUTATION (3)
Allender. Prerequisite: 16:198:509 or equivalent.
Mathematical theory of computing machines. Computable functions, recursive and recursively enumerable sets, recursion and fixed-point theorems, abstract complexity and complexity theoretic analogues of aspects of recursive-function theory, algorithmic (Kolmogoroff) complexity theory.

16:198:540. (S) Combinatorial Methods in Complexity Theory (3)
Allender, Szegedy, Szemerédi. Prerequisites: 16:198:509, 513.
Lower bounds in circuit, communication, and proof complexity. Interactive proof systems, approximation, and consequences.

16:198:541. (S) Database Systems (3)
Borgida, Imielinski. Prerequisites: 01:198:336 or equivalent; 16:198:513. Recommended: 16:198:509 or equivalent.
Relational data model. Relational query languages and their expressiveness. Dependency theory and relational normalization. Physical database design. Deductive databases and object-oriented databases. Optimization of relational queries.

16:198:545. (S) Distributed Systems (3)
Bianchini, Iftode, Martin, Nguyen. Prerequisite: 16:198:519.
Basic mechanisms for building distributed systems (remote-procedure call, synchronization, transactions), components of distributed operating systems (file systems, distributed shared memory), and issues in wide-area distributed systems (security, wide-area clustering).

16:198:552. (S) Computer Networks (3)
Nath, Nguyen. Prerequisite: 01:198:416.
Computer network protocols and architecture. Protocol design. Internetworking and TCP/IP. Medium access, routing, and traffic control. Network security. Integrated and differentiated services. Network programming. Network simulation.

16:198:553. (F) Design of Internet Services (3)
Nath. Prerequisite: 16:198:552.
Internet applications, services, and programming models. Middleware, proxy caches, and directory services. Web server architecture and commodity clustering systems for scalable services. Electronic commerce. Multimedia streaming. Internet security and firewalls.

16:198:556. (F) Parallelism: Algorithms and Complexity (3)
Fredman, Steiger, Szemerédi. Prerequisite: 16:198:513. Recommended: 16:198:505, 514.
Models of parallelism. Complexity classes. Lower bounds, simulations, separation results. Algorithms: arithmetic, comparison tasks, matrices, graphs. Routing and scheduling problems. Architectures and structures.

16:198:580. (S) Topics in Computers in Biomedicine (3)
Farach-Colton, Kulikowski. Prerequisite: 16:198:513 or 520, depending on the term, or permission of instructor.
Survey of computational methods in biology or medicine; topics vary from instructor to instructor and may include computational molecular biology, medical reasoning, and imaging.

16:198:583. (F) Topics in Software Design (3)
Minsky. Prerequisites: Proficiency in at least two of the following areas: database systems, operating systems, programming languages, and AI.
In-depth study of selected topics in the areas of software engineering, distributed computing, and electronic commerce and security. Course leads to research in these areas.

16:198:587. (S) Expert Systems (3)
Kulikowski. Prerequisites: 16:198:530 and permission of instructor.
Scope and characterization of expert systems. Consultation processes and expertise. Knowledge acquisition and representation. Methods of inference under uncertainty and problem-solving strategies. Review of existing expert systems and specialized languages.

16:198:594. (S) Topics in Programming Languages (3)
Ryder. Prerequisite: 16:198:515.
Advanced topics in the design and implementation of programming languages (e.g., compiling for parallel architectures, data-flow analysis and its applications, very high-level program optimization, automatic programming, theory of programming languages).

16:198:596. (S) Topics in the Foundations of Computer Science (3)
Allender, Fredman, Steiger, Szemerédi. Prerequisites: 16:198:509 and, depending on the topic, 16:198:538 and/or 539 and/or 540.
Careful study of papers on the topic selected for the given term. Examples include parallelism and zero-knowledge proofs, randomness and information theory, probabilistic aspects of computation, topics in complexity theory.

16:198:598. Topics in Artificial Intelligence (3)
Prerequisite: 16:198:530 or permission of instructor.
A special topics course covering particular areas of research in artificial intelligence.

16:198:601,602,603,604,605,606. Selected Problems in Computer Science (BA,BA,BA,BA,BA,BA)
Prerequisite: 6 graduate credits in computer science with grades of B+ or better.
In-depth study of a topic chosen by the student and professor.

16:198:607,608. Problems in Numerical Methods (BA,BA)
Gerasoulis, Vichnevetsky. Prerequisites: 16:198:525 or 526 or 527 or equivalent experience, and permission of instructor.
Formal lectures and individual projects under the guidance of the instructor. Topics follow the material covered in 16:198:525,526, and/or 527. Final project may include the implementation and evaluation of computer programs.

16:198:671,672,673,674,675,676. Seminar in Computer Science (3,3,3,3,3,3)
For advanced graduate students who have at least 18 graduate credits in computer science.
Current research. Several seminars are given each term.

16:198:701,702. Research in Computer Science (BA,BA)
Prerequisite: Permission of thesis adviser. For students working on their master's theses or doctoral dissertations.

CURATORIAL STUDIES
(See Art History)

ECOLOGY AND EVOLUTION 215

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Peter J. Morin,**
Environmental and Natural Resources Building, Cook Campus
(732/932-3213)

Members of the Graduate Faculty

Kenneth W. Able, *Professor and Director of the Marine Field Station, CC/FAS–NB; Ph.D., William and Mary*
Ecology and behavior of fishes, marine and estuarine ecology
Tamar Barkay, *Associate Professor of Biochemistry and Microbiology, CC; Ph.D., Maryland*
The role of microorganisms in transformations of metals in the environment
Joanna Burger, *Professor of Biology, FAS–NB, and of Ecology, Evolution, and Natural Resources, CC; Ph.D., Minnesota*
Avian behavior and ecology, salt marsh ecology, ecological risk, reptile behavior
Timothy M. Casey, *Dean of Academic and Student Programs and Professor of Entomology, and of Ecology, Evolution, and Natural Resources, CC; Ph.D., California (Los Angeles)*
Physiological ecology; energetics and thermoregulation, biodiversity
Jonathan J. Cole, *Associate Scientist, Institute of Ecosystem Studies; Ph.D., Cornell*
Aquatic ecology; biogeochemistry; microbiology
Chi-hua Chu, *Assistant Professor of Genetics and Anthropology, FAS–NB; Ph.D., Wayne State*
Evolutionary and developmental genetics
Colomban de Vargas, *Assistant Professor of Marine and Coastal Sciences, CC; Ph.D., Geneva*
Open ocean molecular ecology and evolution; protist biodiversity; microfossils
John Dighton, *Professor of Biology, FAS–C; Ph.D., London*
Role of fungi in nutrient dynamics in forest soils and impacts of pollution
David Drake, *Assistant Professor of Wildlife, CC; Ph.D., North Carolina State*
Wildlife and wildlife damage management on private lands; wildlife policy

David W. Ehrenfeld, *Professor of Biology, and of Ecology, Evolution, and Natural Resources, CC; M.D., Harvard; Ph.D., Florida*
Conservation ecology; biology of marine turtles

Joan G. Ehrenfeld, *Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., CUNY*
Plant community ecology

Douglas E. Eveleigh, *Professor of Biochemistry and Microbiology, and of Ecology, Evolution, and Natural Resources, CC; Ph.D., Exeter*
Microbial ecology, cellulose recycling, endomycorrhizae

Paul Falkowski, *Professor of Geological Sciences and Marine and Coastal Sciences, CC; Ph.D., British Columbia*
Evolution of biogeochemical cycles; photosynthesis; symbiosis and phyto-planktonecology

Stuart E.G. Findlay, *Assistant Scientist, Institute of Ecosystem Studies; Ph.D., Georgia*
Marine/invertebrate ecology

Dunne Fong, *Associate Professor of Biological Sciences, FAS–NB; Ph.D., Princeton*
Biodiversity; free-living parasite protozoa

Susan E. Ford, *Associate Research Professor of Marine and Coastal Sciences, CC; Ph.D., Duke*
Estuarine ecology, host-parasite environment interactions

Randy Gaugler, *Professor of Entomology, CC; Ph.D., Wisconsin*
Invertebrate pathology; insect mating systems, vector biology

Michael Gochfeld, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; M.D., Albert Einstein; Ph.D., CUNY (Queens)*
Avian behavioral ecology; environmental toxicology

Jason Grabosky, *Assistant Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., Cornell*
Urban forestry and urban tree establishment

J. Frederick Grassle, *Director and Professor, Institute of Marine and Coastal Sciences, CC; Ph.D., Duke*
Marine ecology; oceanography

Judith P. Grassle, *Professor of Marine and Coastal Sciences, IMCS/CC; Ph.D., Duke*
Marine invertebrate ecology; population genetics

Edwin J. Green, *Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., Virginia Polytechnic Institute*
Forest ecology; quantitative methods

Peter M. Groffman, *Associate Scientist, Institute of Ecosystem Studies; Ph.D., Georgia*
Terrestrial microbial ecology

Max Haggblom, *Associate Professor of Biochemistry and Microbiology, CC; Ph.D., Helsinski*
Environmental microbiology

Erik Hamerlynck, *Assistant Professor of Biology, FAS–N, Ph.D., Kansas State*
Physiological ecology of terrestrial plant systems

Steven N. Handel, *Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., Cornell*
Plant population ecology; pollination biology; ecological genetics

Jean M. Hartman, *Associate Professor of Landscape Architecture, CC; Ph.D., Connecticut*
Plant community ecology; natural disturbance processes; wetlands

Colleen Hatfield, *Assistant Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., New Mexico*
Spatial distribution of resources; ecosystems

Emanuel B. Hey, *Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., SUNY (Stony Brook)*
Molecular evolution; population genetics

Henry B. John-Alder, *Professor of Animal Sciences, CC; Ph.D., California (Irvine)*
Ecological physiology and endocrinology; herpetology

Karl Kjer, *Assistant Professor of Entomology, CC; Ph.D., Minnesota*
Phylogeny of the trichoptera; molecular phylogenetics

Eric Knox, *Associate Professor of Biological Sciences, FAS–N; Ph.D., Michigan*
Systematics, biogeography, and speciation; adaptation in plants

Richard G. Lathrop, Jr., *Associate Professor of Ecology, Evolution, and Natural Resources, CC: Ph.D., Wisconsin (Madison)*
Remote sensing; landscape ecology

Gene E. Likens, *Senior Scientist and Director, Institute of Ecosystems Studies; Ph.D., Wisconsin*
Limnology; biogeochemistry of streams and lakes; analysis of ecosystems

Gary M. Lovett, *Associate Scientist, Institute of Ecosystem Studies; Ph.D., Dartmouth*
Terrestrial ecosystem ecology; biogeochemistry; air pollution

Richard A. Lutz, *Professor of Marine and Coastal Sciences, CC; Ph.D., Maine*
Marine ecology and paleoecology; shellfish ecology; deep-sea ecology

Michael L. May, *Professor of Entomology, CC; Ph.D., Florida*
Physiological and behavioral ecology; insect ecology

Bonnie J. McCay, *Professor of Anthropology and Human Ecology, CC; Ph.D., Columbia*
Human ecology; fisheries ecology

George R. McGhee, Jr., *Professor of Geology, FAS–NB; Ph.D., Rochester*
Community paleoecology; ecosystem evolution

Terry R. McGuire, *Associate Professor of Biological Sciences, FAS–NB; Ph.D., Illinois*
Behavioral and neural genetics; behavioral ecology

Mark D. Morgan, *Associate Professor of Biology, FAS–C; Ph.D., California (Davis)*
Limnology; biogeochemistry; Pine Barrens ecosystems

Peter J. Morin, *Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., Duke*
Community ecology; herpetology; aquatic entomology

George E.B. Morren, Jr., *Professor of Human Ecology, CC; Ph.D., Columbia*
Human ecology; tropical ecosystems; agriculture; people-animal interactions; remote sensing

Richard S. Ostfeld, *Assistant Scientist, Institute of Ecosystem Studies; Ph.D., California (Berkeley)*
Population and behavioral ecology; small mammals; herbivore-plant interactions

Michael L. Pace, *Associate Scientist, Institute of Ecosystem Studies; Ph.D., Georgia*
Aquatic ecosystems; plankton; microbial ecology

Steward T.A. Pickett, *Scientist, Institute of Ecosystem Studies; Ph.D., Illinois*
Plant populations and community organization; vegetation dynamics

Sridhar Polavarapu, *Associate Professor of Entomology, CC; Ph.D., New Brunswick*
Insect ecology; insect chemical ecology; pest management; biological control

Harry W. Power, *Associate Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., Michigan*
Evolution of social behavior; avian ecology

John A. Quinlan, *Assistant Professor of Marine and Coastal Sciences, CC; Ph.D., North Carolina (Chapel Hill)*
Fisheries ecology; management; biophysical interactions and modeling

Kathleen M. Scott, *Associate Professor of Biological Sciences, FAS–NB; Ph.D., Yale*
Mammalogy; functional morphology; paleoecology; artiodactyl systematics

Peter E. Smouse, *Professor of Theoretical and Applied Genetics, and of Ecology, Evolution, and Natural Resources, CC; Ph.D., North Carolina State*
Mathematical ecology, ecological genetics

Edmund W. Stiles, *Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., Washington*
Plant-animal interactions; evolutionary ecology; vertebrate ecology

David L. Strayer, *Assistant Scientist, Institute of Ecosystem Studies; Ph.D., Cornell*
Freshwater ecology; energy flow; ecology of freshwater invertebrates

Lena Struwe, *Assistant Professor of Ecology, Evolution, and Natural Resources and Plant Sciences, CC; Ph.D., Stockholm*
Evolutionary history, diversity and biogeography of gentians and relatives

Michael V.K. Sukhdeo, *Associate Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., McGill*
Habitat selection behavior of parasitic helminths; parasite ecology

Gary L. Taghon, *Associate Professor of Marine and Coastal Sciences, CC; Ph.D., Washington*
Marine benthic ecology; feeding energetics

Richard Triemer, *Professor of Biological Sciences, FAS–NB; Ph.D., North Carolina (Chapel Hill)*
Evolution of algae and protozoa

Robert Trivers, *Professor of Anthropology, FAS–NB; Ph.D., Harvard*
Natural selection and social theory; evolutionary genetics

Andrew P. Vayda, *Professor of Anthropology and Human Ecology, CC; Ph.D., Columbia*
Human ecology; tropical ecosystems

Costantino Vetriani, *Assistant Professor of Biochemistry and Microbiology and Marine and Coastal Sciences, CC; Ph.D., Rome*
Deep-sea microbiology; extremophiles; adaptations to extreme environments

Daniel Wartenberg, *Associate Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., SUNY (Stony Brook)*
Ordination; spatial pattern; epidemiology

Judith S. Weis, *Professor of Biology, FAS–N; Ph.D., New York*
Effects of environmental factors on the development of aquatic animals

James White, *Associate Professor of Plant Pathology, CC; Ph.D., Texas*
Fungal systematics; ecology of fungi; fungal-plant symbioses

Daniel C. Wilhoft, *Professor of Biology, FAS–NB; Ph.D., California (Berkeley)*
Physiological ecology of ectotherms

Ming Xu, *Assistant Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., California (Berkeley)*
Ecosystem ecology, modeling and management; RS and GIS spatial modeling

Adjunct Members of the Graduate Faculty

Steven E. Clemants, *Vice President for Science, Brooklyn Botanic Garden; Ph.D., CUNY*
Flora of New York metro region, systematics of **Chenopod**

Vlatcheslav Douchenkov, *Research Scientist, Phytech, Inc., CC; Ph.D., Moscow Pedagogical*
Plant response to heavy-metal-contaminated soils

Brian L. Howes, *Assistant Scientist, Woods Hole Oceanographic Institution; Ph.D., Boston*
Biogeochemistry of coastal wetlands

Michael J. Kennish, *Research Marine Scientist in Marine and Coastal Sciences, CC; Ph.D., Rutgers*
Marine pollution, marine ecology, marine geology
C. Lavett Smith, *Curator, American Museum of Natural History; Ph.D., Michigan*
Fish ecology

Programs

The graduate program in ecology and evolution is concerned with the relations between organisms and the environment and with interactions among organisms. It is sponsored by participating faculties in the biological sciences. Normally, a one-year residence of two full-time, consecutive terms following the qualifying examination is required for the Ph.D. candidate. A minimum of 72 credits (30 in course work, 42 in research) is required. Two M.S. options are available: with a thesis or without. Both M.S. programs require 30 credits, 18 of which must be at the graduate level.

The program provides a broad spectrum of courses and research opportunities to qualified students who seek careers in university teaching and research or employment opportunities in governmental agencies or private institutions.

Areas of specialization include behavior, conservation biology, ecosystem ecology, evolutionary biology, marine biology, population and community ecology, population genetics, molecular evolution, restoration ecology, and behavior.

Graduate Courses

16:215:506. (F) ESTUARINE ECOLOGY (4)
Able. Sem. 2 hrs., lab. 3 hrs.
Fundamental study of aquatic organisms in the estuarine waters of coastal New Jersey; life cycles, food chains, and the relationships of organisms to one another.

16:215:507. ADVANCED PLANT SYSTEMATICS (4)
Struwe. Prerequisite: Principles of botany or vascular plant systematics.
Broad, evolutionary overview of all vascular plants, from club mosses and ferns to conifers and flowering plants. Principles of classification and field identification, morphology, and basic concepts in evolutionary studies in botany. Independent project.

16:215:510. CONSERVATION ECOLOGY (3)
D. Ehrenfeld
Biological, social, and economic causes of the major threats to ecosystems and species. The role of universities and human communities. Changing world views and possibilities for constructive response.

16:215:513. POPULATION GENETICS (3)
Smouse. Prerequisite: Genetics.
Factors affecting gene frequencies in populations and leading to the origin of new species. An introduction to the analysis of continuously distributed polygenic traits.

16:215:514. CONSERVATION GENETICS (3)
Focus on applications of population genetic and quantitative genetic approaches to captive breeding and *in situ* conservation of endangered species. Genetic considerations intertwined with demographic problems facing species in decline resulting from habitat loss or fragmentation.

16:215:515. (F) NATURAL HISTORY OF NEW JERSEY (3)
Lec. 2 hrs., lab. 3 hrs. Prerequisite: General biology.
Ecological aspects of the natural history of New Jersey. Field and laboratory studies of special use and interest to biology teachers.

16:215:520. LANDSCAPE ECOLOGY (3)
Hatfield. Prerequisite: Univariate statistics.
Spatial patterning, its causes, development, and relevance to ecological systems. Conceptual and theoretical framework of landscape ecology; quantitative and modeling tools.

16:215:525. (F) ECOLOGY OF FRESHWATER ORGANISMS (4)
Lec. 3 hrs., lab. 3 hrs. Prerequisite: Limnology or aquatic biology.
Detailed consideration of distribution, abundance, and metabolism of organisms in lakes and streams. An introduction to the theory and techniques of systems ecology.

16:215:528. (S) BEHAVIORAL ECOLOGY OF FISH (3)
Able. Prerequisite: 01:119:420.
Investigation into fish behavior, with emphasis on the ecological significance of migrations, reproduction, feeding, habitat selection, and antipredator strategies. Student research topics.

16:215:531. (F) ADVANCED ORNITHOLOGY (3)
Study of avian biology, including taxonomy, population dynamics, and distribution of birds, and a critical review of current ornithological research. The laboratory consists of field and museum experience and independent research.

16:215:533. (S) THE BEHAVIOR OF ANIMAL POPULATIONS (3)
Burger. Prerequisite: Animal behavior or ecology.
Topics in ecological adaptations of behavior; emphasis on the population level. Student research topics.

16:215:546. BEHAVIORAL GENETICS (4)
McGuire. Prerequisites: Background in genetics, behavior.
Recommended: Statistics.
Single and multiple gene effects on behavior; methods of behavior-genetic analysis. Mechanisms of action of behavior genes. Darwinian considerations in behavioral evolution. Evolution of social systems.

16:215:550. ADVANCED EVOLUTION (4)
Handel, Hey. Prerequisite: Genetics.
Examination of the major elements and controversies of evolutionary theory. Emphasis on genetic variation, natural selection, adaptation, and speciation.

16:215:555. ECOLOGY AND ECOLOGICAL RISK (3)
Burger
Principles of ecology and risk analysis, environmental hazards and resultant risk analysis.

16:215:565. COMMUNITY DYNAMICS (4)
Morin
Patterns and processes involving sets of two or more coexisting species. Theoretical and empirical studies.

16:215:570. MOLECULAR EVOLUTION (3)
Hey
Analysis of actual data sets estimating historical process. Evolutionary origins of DNA; theoretical and empirical aspects; using DNA sequence data to determine evolutionary history.

16:215:575. (F) QUANTITATIVE ECOLOGY AND EVOLUTION (3)
Morin. Prerequisite: Calculus. Recommended: FORTRAN programming.
Application of differential equations and linear algebra to specific ecological phenomena (e.g., growth, competition, predator-prey). Dynamic modeling of simple (three- and four-component) ecosystems; students develop their own models.

16:215:582. TOPICS IN SOCIOBIOLOGY (3)
Power. Prerequisites: Genetics, ecology, and permission of instructor.
Application of Darwinian reasoning and the comparative method to the study of the evolution and expression of social behavior. Rigorous formation and testing of disprovable hypotheses emphasized.

16:215:585. INTRODUCTION TO ECOLOGICAL AND ENVIRONMENTAL MODELING (3)
Xu. Prerequisites: College-level calculus and basic statistics.
Mathematical and statistical tools for ecological and environmental modeling. General model formulation, validation, hypothesis testing, nonlinear phenomena, and forecasting.

16:215:586. ECOSYSTEM MODELING, QUANTITATIVE ANALYSIS FOR ECOSYSTEM MANAGEMENT (3)
Xu. Prerequisite: 16:215:585.
Quantifying major ecosystem functions based on current knowledge and understanding of ecosystem processes and their interactions from cell to ecosystem scales; modeling photosynthesis, respiration, evapotranspiration, soil moisture, energy balance, stomatal conductance, and leaf area index; basic spatial modeling techniques and applications of remote sensing and GIS in ecosystem modeling. Application of models to ecosystem management and global environment change.

16:215:587. CONCEPTS AND METHODS IN EVOLUTION (4)
Kjer, Smouse, Stiles
Lecture, laboratory, and field survey of selected concepts in evolutionary biology. Topics include predator-prey interactions, mutualisms, population variation, genetic structure of populations, spatial patterning, speciation, systematics, and cladistics, among others.

16:215:588. TOPICS IN ADVANCED ECOLOGY (3)
Literature review and synthesis of a selected current topic in applied or theoretical ecology.

16:215:590. (S) POPULATION ECOLOGY (4)
Lec./sem. 3 hrs., lab./field 3 hrs. Prerequisite: Ecology.
Population dynamics and demography, natural selection and evolution, life history strategies, population regulatory mechanisms, species interactions and coevolution, variability among populations and ecological differentiation, and island biogeography.

16:215:595. (F) COADAPTION OF PLANTS AND ANIMALS (3)
Stiles. Prerequisite: Botany or ecology or evolutionary biology.
Introduction to coevolution, plant-herbivore interaction, pollination biology, seed predation, and dispersal.

16:215:598. CONCEPTS AND METHODS IN ECOLOGY (4)
In-depth investigation of at least three current topics in ecology. Topics include both theoretical and applied examples; field work, lab exercises, and term papers.

16:215:599,600. SPECIAL TOPICS IN ECOLOGY (BA,BA)
Topics vary every term. Current listing can be found on the web site.

16:215:601,602. SEMINAR IN ECOLOGY (1,1)
Sukhdeo
Introductory seminar required for all first-year ecology and evolution students.

16:215:603,604. SPECIAL TOPICS IN ECOLOGY (BA,BA)
Topics vary by term. Current listing can be found on web site.

16:215:605,606. ADVANCED PROBLEMS IN ECOLOGY (BA,BA)
Individual study in an area of expertise of the faculty.

16:215:650. FUNDAMENTALS OF ECOSYSTEM ECOLOGY (4)
Critical review of ecosystem ecology, including biogeochemical cycles and budgets, ecosystem energetics, the theory and history of ecosystem ecology, and the response of ecosystems to disturbance.

16:215:701,702. RESEARCH IN ECOLOGY (BA,BA)

Graduate Courses in Other Programs

Descriptions for the courses listed below can be found elsewhere in this catalog and in the graduate catalogs for Camden and Newark. In addition to these courses taught by members and associates of the ecology program, many other courses of interest to ecology graduate students are offered by the programs in entomology, environmental sciences, geography, geological sciences, meteorology, and plant science and technology.

16:070:559. EVOLUTION OF BEHAVIOR (3)

16:070:567. HUMAN VARIATION (3)

56:120:503. ESTUARINE BIOLOGY (3)

56:120:505. MARINE BIOLOGY (4)

56:120:507. PLANT GEOGRAPHY (4)

56:120:590. POPULATION ECOLOGY (3)

16:370:507. BIOLOGICAL CONTROL OF INSECT PESTS (3)

16:370:525. INSECT ECOLOGY (3)

16:450:617. SEMINAR IN REMOTE SENSING OF THE BIOSPHERE (3)

16:460:538. EVOLUTIONARY PALEOECOLOGY (3)

16:681:502. MOLECULAR GENETICS (3)

16:681:572. MICROBIAL ECOLOGY AND BIODIVERSITY (4)

16:681:580. FUNDAMENTALS OF MOLECULAR GENETICS (3)

16:761:520. ENVIRONMENTAL PHYSIOLOGY (3)

16:765:503. METHODS IN PLANT SYSTEMATICS (3)

16:765:522. APPLIED PLANT SCIENCE STATISTICS (3)

16:960:582. INTRODUCTION TO METHODS AND THEORY OF PROBABILITY (3)

16:960:590. DESIGN OF EXPERIMENTS (3)

ECONOMICS 220

Degree Programs Offered: **Master of Arts, Doctor of Philosophy**
Director of Graduate Program: **Professor Richard McLean,**
  New Jersey Hall, College Avenue Campus (732/932-7451)
Web Site: *http://www.economics.rutgers.edu*
Email: *gradprog@econ.rutgers.edu*

Members of the Graduate Faculty

Robert J. Alexander, *Professor Emeritus of Economics, FAS–NB;*
  Ph.D., Columbia
  Latin American economic development and politics; history of radical movement
Rosanne Altshuler, *Associate Professor of Economics, FAS–NB;*
  Ph.D., Pennsylvania
  Tax-policy analysis
Monroe Berkowitz, *Professor Emeritus of Economics, FAS–NB;*
  Ph.D., Columbia
  Economics of disability programs
Douglas H. Blair, *Executive Vice Dean and Professor of Economics, FAS–NB;*
  Ph.D., Yale
  Microeconomic theory; social choice theory
Michael D. Bordo, *Professor of Economics, FAS–NB; Ph.D., Chicago*
  Monetary history and theory
John F. Burton, Jr., *Professor of Industrial Relations and Human Resources,*
  SMLR; Ph.D., Michigan
  Social insurance; employment law; collective bargaining
Roberto Chang, *Associate Professor of Economics, FAS–NB; Ph.D., Pennsylvania*
  Macroeconomic policy, open economy macroeconomics
Manoranjan Dutta, *Professor of Economics, FAS–NB; Ph.D., Pennsylvania*
  U.S.-Asia economics; econometric models; macroeconomics: new perspectives
Ira N. Gang, *Professor of Economics, FAS–NB; Ph.D., Cornell*
  Economic development, labor economics
Gary A. Gigliotti, *Professor of Economics, FAS–NB; Ph.D., Columbia*
  Economic theory and social choice
Norman Glickman, *University Professor, EJBSPPP; Ph.D., Pennsylvania*
  Urban and regional economics
H. Peter Gray, *Professor Emeritus of Economics; Ph.D., California*
  International trade, business and finance
Mark R. Killingsworth, *Chair and Professor of Economics, FAS–NB;*
  D.Phil., Oxford
  Labor economics
Roger W. Klein, *Professor of Economics, FAS–NB; Ph.D., Yale*
  Econometrics
Cheng-few Lee, *Professor of Finance, RBS; Ph.D., SUNY (Buffalo)*
  Applied econometrics; options and futures; corporate finance
Peter D. Loeb, *Professor of Economics, FAS–N; Ph.D., Rutgers*
  Applied econometrics and transportation economics
Matityahu Marcus, *Professor Emeritus of Economics, FAS–NB; Ph.D., Brown*
  Competition in regulated industries; cost of capital of public utilities
Richard P. McLean, *Professor of Economics, FAS–NB; Ph.D., SUNY*
  (Stony Brook)
  Game theory and its applications
Bruce Mizrach, *Associate Professor of Economics, FAS–NB; Ph.D., Pennsylvania*
  Macroeconomics; international finance; time-series econometrics

Peter J. Parks, *Associate Professor of Agricultural Economics, CC; Ph.D., California (Berkeley)*
Environmental and resource economics; policy analysis; applied econometrics

Martin K. Perry, *Professor of Economics, FAS–NB; Ph.D., Stanford*
Vertical integration and controls; monopolistic competition

Carl E. Pray, *Professor of Agricultural Economics, CC; Ph.D., Pennsylvania*
Technical change in LDC agriculture; science and technology policy

Thomas J. Prusa, *Professor of Economics, FAS–NB; Ph.D., Stanford*
International trade; trade policy

Hugh T. Rockoff, *Professor of Economics, FAS–NB; Ph.D., Chicago*
American economic history

Jeffrey Rubin, *Professor of Economics, FAS–NB; Ph.D., Duke*
Health economics

Louise B. Russell, *Professor of Economics, FAS–NB; Ph.D., Harvard*
Economics of medical care; cost-effectiveness and cost-benefit analysis

Kazuo Sato, *Professor Emeritus of Economics, FAS–NB; Ph.D., Yale*
Macroeconomic theory and international economics

Stephanie Schmitt-Grohe, *Associate Professor of Economics, FAS–NB; Ph.D., Chicago*
Macroeconomics

Joseph J. Seneca, *University Professor, EJBSPPP; Ph.D., Pennsylvania*
Environmental economics; state and local economic policy

Neil Sheflin, *Associate Professor of Economics, FAS–NB; Ph.D., Rutgers*
Applied econometrics; financial economics

Hilary Sigman, *Associate Professor of Economics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Environmental economics; public economics

Leslie E. Small, *Professor of Agricultural Economics, CC; Ph.D., Cornell*
Irrigation management and agricultural development in Asia

Barry Sopher, *Associate Professor of Economics, FAS–NB; Ph.D., Iowa*
Experimental economics

Robert C. Stuart, *Professor of Economics, FAS–NB; Ph.D., Wisconsin*
Comparative economic systems

Norman Swanson, *Associate Professor of Economics, FAS–NB; Ph.D., California (San Diego)*
Time series econometircs; financial econometrics; macroeconometrics

Shanti S. Tangri, *Professor Emeritus of Economics, FAS–NB; Ph.D., California (Berkeley)*
Population; development; environmental economics

Michael K. Taussig, *Professor Emeritus of Economics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Income and wealth distributions

Hiroki Tsurumi, *Professor of Economics, FAS–NB; Ph.D., Pennsylvania*
Bayesian econometrics and statistical inference

Eugene N. White, *Professor of Economics, FAS–NB; Ph.D., Illinois*
Monetary and financial history

John D. Worrall, *Professor of Economics, FAS–C; Ph.D., Rutgers*
Labor supply; workers'compensation insurance; economics of disability

Associate Members of the Graduate Faculty

Colin Campbell, *Assistant Professor of Economics, FAS–NB; Ph.D., Northwestern*
Industrial organization

Oriol Carbonell-Nicolau, *Assistant Professor of Economics, FAS–NB; Ph.D., New York*
Public economics; microeconomic theory

Jessie C. Hartline, *Associate Professor Emeritus of Economics, FAS–NB; Ph.D., Rutgers*
Finance; international finance development; service-sector productivity

Joseph P. Hughes, *Associate Professor of Economics, FAS–NB; Ph.D., North Carolina*
Production economics, efficiency measurement, banking

Douglas L. Kruse, *Professor of Human Resource Management, SMLR; Ph.D., Harvard*
Profit sharing; employee ownership; worker displacement; wage differentials; disability

John Landon-Lane, *Assistant Professor of Economics, FAS–NB; Ph.D., Minnesota*
Econometrics; macroeconomics; growth; development

Jinpeng Ma, *Associate Professor of Economics, FAS–C; Ph.D., SUNY (Stony Brook)*
Economic theory

Filippo Occhino, *Assistant Professor of Economics, FAS–NB; Ph.D., Chicago*
Monetary economics

Daijiro Okada, *Assistant Professor of Economics, FAS–NB; Ph.D., SUNY (Stony Brook)*
Game theory

Oded Palmon, *Associate Professor of Finance, RBS; Ph.D., Chicago*
Public finance; applied microeconomics; corporate finance

Argia M. Sbordone, *Assistant Professor of Economics, FAS–NB; Ph.D., Chicago*
Macroeconomics; business-cycle analysis; monetary economics

Programs

The M.A. and Ph.D. are full-time day programs. Entering M.A. and Ph.D. students are expected to have a basic knowledge of calculus (differential and integral) and linear algebra, which are used in the basic microeconomics and statistics courses. Courses 16:220:500, 501, 502, 504, 505, 506, and 507 are prerequisites for each elective field course.

The M.A. program offers students two options, one with a master's essay and one without. Under the first plan, students take 30 hours of course work and complete a master's essay. The oral examination in defense of the essay, which serves as the comprehensive examination for the master's degree, includes tests on economic theory and quantitative methods. Students who complete 30 credits and pass the theory portions of the Ph.D. qualifying examination can earn the M.A. degree without writing a master's essay. Students in the M.A. program are required to take two term courses in microeconomic theory and macroeconomic theory, one course in statistical methods, and two courses in econometrics.

The Ph.D. program consists of course work, qualifying examinations, and the dissertation. The Ph.D. requires 48 credits of course work (16 courses). Because students are not permitted to take more than four courses a term, course work for the Ph.D. requires at least two academic years to complete. Graduate and teaching assistants normally are not permitted to take more than three courses a term. The master of philosophy degree is available to doctoral candidates.

Ph.D. students take one course in mathematical methods, two courses in microeconomic theory, two courses in macroeconomic theory, 6 credits in statistical methods and econometrics, one course in economic history, and one course in either applied microeconometrics or macroeconometrics. The balance of the course of study is determined by each student's requirements. To ensure breadth of coverage, each Ph.D. student is required to take at least two courses in two elective fields offered in the program.

There are nine elective fields: economic theory, econometrics, economic history, monetary theory, public finance, development economics and economic systems, international economics, labor and human resources, and industrial organization.

The first part of the Ph.D. qualifying examination is a written test in microeconomic theory and macroeconomic theory. Students are expected to take this part after one year of course work. The second part of the qualifying exam, consisting of exams in two elective fields, must be taken within 18 months of successful completion of the microeconomic and macroeconomic theory examinations. A student who fails any written examination must retake it at the next examination period. (Examinations are given twice yearly.)

Doctoral students also are required to complete a second-year research paper over the summer of their second year and write a dissertation proposal in the summer of their third year. The dissertation, which is written under the supervision of a faculty committee, must be defended in a final examination before the student's committee.

Graduate Courses

16:220:500. MATHEMATICAL METHODS FOR MICROECONOMICS (3)
Prerequisites: Background in calculus and linear algebra.
Basic mathematical tools for consumer and producer theory. Compact sets; differentiability; convex sets; separation theorems; constrained optimization and the Kuhn-Tucker theorem; applications in consumer and producer theory.

16:220:501. MICROECONOMIC THEORY I (3)
Corequisite: 16:220:500 or permission of instructor.
General equilibrium theory; the Arrow-Debreu model, decision making under uncertainty; the von Neumann-Morgenstern theory, risk aversion, applications to insurance problems and portfolio choice, applications to competitive equilibrium with uncertainty.

16:220:502. MICROECONOMIC THEORY II (3)
Prerequisite: 16:220:501.
Introduction to the theory of games and related economic models with informational asymmetries. Topics include noncooperative games and models of moral hazard and adverse selection.

16:220:503. MATHEMATICAL METHODS FOR MACROECONOMICS (3)
Prerequisites: Background in calculus and linear algebra.
Basic mathematical tools for dynamic economic models. Linear algebra from echelon form to projection operators; quadratic forms; linear difference and differential equations; dynamic programming and control theory; applications to dynamic models of macroeconomics; growth and human capital.

16:220:504. MACROECONOMIC THEORY I (3)
Introduction to economic dynamics, economic growth, business cycles, and the role of macroeconomic policy.

16:220:505. MACROECONOMIC THEORY II (3)
Prerequisite: 16:220:504.
General equilibrium modeling of the macroeconomy. Topics include the stochastic growth model and multiple equilibrium. Empirical validation is stressed.

16:220:506. ADVANCED ECONOMIC STATISTICS (3)
Prerequisites: Background in calculus and linear algebra.
Background in statistical inferential procedures used in economic-data analyses. Probability, random variables and distributions, estimation, testing hypotheses, and sampling distribution of estimators.

16:220:507. ECONOMETRICS I (3)
Prerequisite: 16:220:506 or equivalent.
Focus on measurement of economic parameters. Statistical estimation and inference of regression equation models. Properties of OLS, GLS, JGLS, 2SLS, 3SLS, and Maximum Likelihood Estimators. Introduction to time-series analysis and quantitative-response models. Use of linear algebra and statistical packages. Emphasis is on theory.

16:220:508. ECONOMETRICS II (3)
Prerequisite: 16:220:507.
Estimation and testing in simultaneous equation systems. Multivariate methods and time series analysis. Bayesian inference in econometrics.

16:220:509. APPLIED ECONOMETRICS FOR MICROECONOMICS (3)
Prerequisite: 16:220:507 or permission of instructor.
Econometric tools for empirical microeconomic models. Parametric and nonparametric qualitative choice models; survival analysis. Recent papers discussed.

16:220:510. APPLIED ECONOMETRICS FOR MACROECONOMICS (3)
Prerequisite: 16:220:507 or permission of instructor.
Econometric tools for empirical macroeconometric time-series models. Exogeneity tests; spectral analysis; nonstationarity; state-space models; structural shifts and prediction. Recent papers discussed.

16:220:513. MONETARY THEORY (3)
Theories of the role of money in relation to the volume of economic activity and the price level.

16:220:514. STRUCTURE OF THE FINANCIAL SYSTEM (3)
The financial system and its relationship to the real sector, including portfolio theory, the term structure of interest rates, and other theoretical and empirical issues in finance.

16:220:515. PUBLIC ECONOMICS I (3)
Welfare theory, collective action, externalities, public goods, benefit-cost analysis, social-welfare programs, social insurance.

16:220:516. PUBLIC ECONOMICS II (3)
Tax-policy analysis. Optimal taxation; tax-incidence analysis; the efficiency costs of taxation; and the measurement of the effects of taxation on economic behavior.

16:220:517. THE ECONOMICS OF THE STATE AND LOCAL PUBLIC SECTOR (3)
Economics of state and local governments. Evolution of federalism; expenditure and revenue decisions and intergovernmental grants; stabilization and distributional aspects of state/local finances. Several specific state/local problems.

16:220:518. INTERNATIONAL ECONOMICS I (3)
Major determinants of international trade flows, including technological differences, factor endowments, and monopolistic competition. Recent theoretical and empirical innovations, including theories of tariff formation and the political economy of trade policy, and evaluations of competing explanations of trade flows.

16:220:519. INTERNATIONAL ECONOMICS II (3)
Open economy macroeconomics. Theory of the balance of payments and balance-of-payments adjustment. International business cycles; current account and fiscal policy; exchange-rate-based inflation stabilization.

16:220:520. ECONOMICS OF THE LABOR MARKET (3)
Theory and evidence on labor supply, static and dynamic. Theory and evidence on labor demand. Wage differentials and unemployment. Applications to policy problems: economics of the welfare system; low-income labor markets. Economics of trade unions.

16:220:521. ECONOMICS OF HUMAN RESOURCES (3)
Analysis of advanced topics in labor economics, with emphasis on prospects for original research. Topics may include investment in human capital; job search, matching, and turnover; labor contracts; race and sex discrimination; bargaining and strikes; economics of the family; population economics; unemployment; distribution of earnings.

16:220:522. INDUSTRIAL ORGANIZATION I (3)
Models of imperfect competition. Applications to price discrimination, vertical integration, product quality, advertising, and research and development. Strategic models of entry deterrence and contracting. Implications for antitrust policy. Empirical research on industry structure, conduct, and performance.

16:220:523. INDUSTRIAL ORGANIZATION II (3)
Natural monopoly and rate-of-return regulation. Optimal pricing including Ramsey, nonlinear, and peak-load pricing. Regulation models with uncertainty or asymmetric information. Regulation of price, entry, product quality, health, safety, and the environment. Empirical research on performance in regulated industries.

16:220:525. ECONOMIC SYSTEMS (3)
Analysis of differing economic systems with emphasis on plan/market comparisons, performance, economic reform, and contemporary issues of transition.

16:220:526. ECONOMIC DEVELOPMENT I (3)
Problems of resource allocation for promoting economic growth and structural change in the context of poverty and inequality.

16:220:527. ECONOMIC DEVELOPMENT II (3)
Selected topics in contemporary development economics.

16:220:540. EUROPEAN ECONOMIC HISTORY (3)
Origins and spread of industrialization; world war and depression; economic integration; and European union.

16:220:541. AMERICAN ECONOMIC HISTORY (3)
The colonial economy; economics of slavery and race; industrialization; development of agriculture; banking and financial markets; the Great Depression; the role of government; and long-term economic growth.

16:220:545. UNCERTAINTY AND IMPERFECT INFORMATION (3)
Blair, McLean. Prerequisite: 16:220:501.
Theory of choice under risk and uncertainty, risk aversion, stochastic dominance. Selected applications include contingent claims, rational expectations, screening, search, adverse selection, moral hazard, agency, common knowledge, and games of incomplete information.

16:220:546. TOPICS IN GAME THEORY (3)
Introduction to topics in noncooperative and cooperative game theory that are of relevance to economic problems.

16:220:547. THEORY OF SOCIAL CHOICE AND VOTING (3)
Selected problems in the design and economic analysis of voting systems. Emphasis on the role of voting institutions in various applied contexts in micro- and macroeconomics.

16:220:548. ADVANCED TOPICS IN MICROECONOMICS (3)
Topics chosen by instructor may include theory of optimal control, general equilibrium, natural resources, incomplete markets.

16:220:549. EXPERIMENTAL ECONOMICS (3)
Introduction to analysis by experimental methods of selected problems in economic theory, focusing on theory of individual choice under uncertainty and game theory, as well as bargaining theory, industrial organization, social choice theory, and financial markets.

16:220:602. SEMINAR IN ECONOMETRICS (3)
Statistical inference in econometrics from Bayesian and non-Bayesian points of view. Special topics may include inference on structural shifts, model selection, Kalman-filter models, and qualitative choice models. Semiparametric and nonparametric models: estimation and inference.

16:220:603. SEMINAR IN MONETARY THEORY (3)

16:220:604. SEMINAR IN PUBLIC ECONOMICS (3)
Advanced topics with emphasis on the main current controversies in the field.

16:220:605. SEMINAR IN LABOR AND HUMAN RESOURCES (3)
Special topics. Topics have included economics of transfer programs, economics of health, economics of fertility.

16:220:606. SEMINAR IN INTERNATIONAL ECONOMICS (3)

16:220:607. SEMINAR IN ECONOMICS OF LATIN AMERICA (3)

16:220:608. SEMINAR IN ECONOMIC SYSTEMS (3)
Analysis of selected topics relating to the comparison of planned and market economic systems and related issues of transition.

16:220:609. SEMINAR IN ECONOMIC DEVELOPMENT (3)
Advanced topics in development economics emphasizing skills of modeling and estimation.

16:220:610. SEMINAR IN MICROECONOMICS (3)
Papers by students, faculty, and visiting scholars on topics selected by the seminar participants.

16:220:612. SEMINAR IN MACROECONOMICS (3)
Topics and controversies at the frontier of macroeconomics. Emphasis on development of analytical skills and use of empirical and theoretical tools.

16:220:613. SEMINAR IN APPLIED ECONOMETRICS (3)
Applied work in macroeconometrics and microeconometrics; use of data and standard statistical packages.

16:220:614. SEMINAR IN ECONOMIC HISTORY (3)
Selected topics in recent research in economic history.

16:220:620. INDIVIDUAL STUDIES IN ECONOMICS (3)

16:220:701,702. RESEARCH IN ECONOMICS (BA,BA)

EDUCATION 300

Degree Program Offered: **Doctor of Philosophy**
Director of Graduate Program: **Professor Angela O'Donnell,** 10 Seminary Place, College Avenue Campus (732/932-7496, ext. 8104)

Members of the Graduate Faculty

Lara Alcock, *Assistant Professor of Learning and Teaching, GSE; Ph.D., Warwick*
Learning and teaching of proof-oriented mathematics
Steven Barnett, *Professor of Educational Theory, Policy, and Administration, GSE; Ph.D., Michigan*
Economics of education; educational policy; evaluation
Harold Beder, *Professor of Educational Theory, Policy, and Administration, GSE; Ed.D., Columbia*
Adult-literacy policy; adult education
Alisa A. Belzer, *Assistant Professor of Educational Theory, Policy, and Administration, GSE; Ph.D., Pennsylvania*
Adult-literacy education, professional development and policy
Katrina E. Bulkley, *Assistant Professor of Educational Theory, Policy, and Administration, GSE; Ph.D., Stanford*
Educational policy and politics, educational reform, and school choice
Gregory Camilli, *Professor of Educational Psychology, GSE; Ph.D., Colorado*
Statistics and measurement
Kenneth D. Carlson, *Professor of Educational Theory, Policy, and Administration, GSE; Ed.D., SUNY (Buffalo)*
Social studies education, educational equity
Clark Chinn, *Associate Professor of Educational Psychology, GSE; Ph.D., Illinois (Urbana-Champaign)*
Educational psychology
Amy Cohen, *Professor of Mathematics, FAS–NB; Ph.D., California (Berkeley)*
Mathematics
Mary Elizabeth Curran, *Assistant Professor of Learning and Teaching, GSE; Ph.D., Wisconsin*
Issues in language education, multicultural education
Richard DeLisi, *Professor of Educational Psychology, GSE; Ph.D., Catholic*
Developmental psychology
Bari Erlichson, *Assistant Professor of Public Policy, EJBSPPP; Ph.D., Stanford*
American government; education policy
Eugenia Etkina, *Associate Professor of Learning and Teaching, GSE; Ph.D., Moscow State Pedagogical*
Mathematics and science education
Richard Falk, *Professor of Mathematics, FAS–NB; Ph.D., Cornell*
Applied mathematics; numerical analysis
William Firestone, *Professor of Educational Theory, Policy, and Administration, GSE; Ph.D., Chicago*
Educational policy; policy implementation; math standards implementation
William Garner, *Associate Professor of Educational Theory, Policy, and Administration, GSE; Ed.D., Pennsylvania State*
Education administration; finance policy
James M. Giarelli, *Professor of Educational Theory, Policy, and Administration, GSE; Ph.D., Florida*
Educational philosophy and policy; ethics and education; civic education
Martin Gliserman, *Associate Professor of English, FAS–NB; Ph.D., Indiana*
Psychoanalysis/literature (narrative)
Susan Golbeck, *Associate Professor of Educational Psychology, GSE; Ph.D., Pennsylvania State*
Cognitive development
Gerald Goldin, *Professor of Learning and Teaching, GSE; Ph.D., Princeton*
Mathematics education; theoretical physics
David Guston, *Associate Professor of Public Policy, EJBSPPP; Ph.D., Massachusetts Institute of Technology*
Public policy; role of experts
Sandra Harris, *Professor of Psychology, FAS–NB/GSAPP; Ph.D., New York (Buffalo)*
Education of autistic children
Cindy Hmelo-Silver, *Assistant Professor of Educational Psychology, GSE; Ph.D., Vanderbilt*
Cognitive and instructional strategies
Linda Lederman, *Professor of Communication, SCILS; Ph.D., Rutgers*
Communication and experiential learning; qualitative research methods
Barbara Lee, *Professor of Human Resource Management, SMLR; Ph.D., Ohio State*
Policy; management industrial relations and human resources
Michael Lewis, *Professor of Psychology, UMDNJ–RWJMS; Ph.D., Pennsylvania*
Developmental psychology
Catherine Lugg, *Assistant Professor of Educational Theory, Policy, and Administration, GSE; Ph.D., Pennsylvania*
Education policy/politics
Carolyn Maher, *Professor of Learning and Teaching, GSE; Ed.D., Rutgers*
Mathematics education

Lorraine McCune, *Professor of Educational Psychology, GSE; Ed.D., Rutgers*
Developmental psychology
Richard Miller, *Assistant Professor of English, FAS–NB; Ph.D., Pittsburgh*
Pedagogy; composition theory; history of educational reform
Naftaly Minsky, *Professor of Computer Science, FAS–NB; Ph.D., Hebrew*
Computer science
Lesley Morrow, *Professor of Learning and Teaching, GSE; Ph.D., Fordham*
Literacy development
Joseph Naus, *Professor of Statistics, FAS–NB; Ph.D., Harvard*
Statistics and probability
Angela O'Donnell, *Professor of Educational Psychology, GSE; Ph.D.,*
Texas Christian
Educational psychology
Douglas Penfield, *Professor of Educational Psychology, GSE; Ph.D.,*
California (Berkeley)
Educational statistics and measurement
Wallis Reid, *Associate Professor of Learning and Teaching, GSE; Ph.D., Columbia*
Linguistics
Fred S. Roberts, *Professor of Mathematics, FAS–NB/DIMACS; Ph.D., Stanford*
Discrete mathematical models; graph theory; decision making;
measurement theory
Joseph Rosenstein, *Professor of Mathematics, FAS–NB; Ph.D., Cornell*
Mathematics education
Alan Rosenthal, *Professor of Public Policy, EJBSPPP; Ph.D., Princeton*
Political science
Sharon Ryan, *Assistant Professor of Learning and Teaching, GSE;*
Ph.D., Columbia
Early childhood education
Larry Scanlon, *Associate Professor of English, FAS–NB; Ph.D., Johns Hopkins*
Medieval studies theory; pedagogy; humanities computing
Jeffrey Smith, *Professor of Educational Psychology, GSE; Ph.D., Chicago*
Measurement; research methods
Michael Smith, *Associate Professor of Learning and Teaching, GSE;*
Ph.D., Chicago
Secondary English education
Dorothy Strickland, *State of New Jersey Professor of Reading, GSE; Ph.D.,*
New York
Literacy: reading and writing development
Daniel Tanner, *Professor of Educational Theory, Policy, and Administration, GSE;*
Ph.D., Ohio State
Curriculum policy at federal, state, and local levels
Saundra Tomlinson-Clarke, *Associate Professor of Educational Psychology, GSE;*
Ph.D., Florida State
Multicultural, psychosocial development
Barbara Turnbull, *Assistant Professor of Educational Psychology, GSE; Ph.D.,*
British Columbia
Evaluation and measurement
Kay Vandergrift, *Professor of Library and Information Science, SCILS;*
Ed.D., Columbia
Library services for children; educational media services
Carl Van Horn, *Professor of Public Policy, EJBSPPP; Ph.D., Ohio State*
Employment policy and public policy
Stanley Vitello, *Professor of Educational Psychology, GSE; Ph.D., Columbia*
Special education law and policy
Carol Weinstein, *Professor of Learning and Teaching, GSE; Ed.D., Harvard*
Classroom management; learning to teach
Robert Wilson, *Professor of Mathematics, FAS–NB; Ph.D., Yale*
Mathematics
Nancy Wolff, *Associate Professor of Urban Studies and Community Health,*
EJBSPPP; Ph.D., Iowa
Methodology; costing methods; program evaluation
John Young, *Associate Professor of Educational Psychology, GSE; Ph.D., Stanford*
Educational statistics and measurement

Programs

The Ph.D. in education prepares individuals for faculty and research positions in academia, government, and the private sector. There are four areas of focus: educational policy, mathematics education, language and literacy education, and educational psychology.

In the educational policy focus, students research specific educational policy issues and examine how those policies get formulated and how they are implemented. They also look at the intended and unintended outcomes of these educational policies. Graduates of the program are prepared to seek research jobs in academia, government, or business.

Students opting for the mathematics education track learn how to conduct basic research on the ways people at all age levels learn and deal with mathematical concepts. Students research the psychology of learning mathematics and the way that individuals solve problems. A strong background in mathematics, statistics ,

or computer science is required for admission. The program is designed to prepare students for academic careers, as opposed to the Ed.D. program, which develops school leaders in mathematics education.

In the language and literacy focus, students investigate the range of literacies in a global, multicultural society. They look at particular curricular choices and instructional strategies that foster learning. They examine the authoritative use of language in a wide range of settings and review the history and politics of language and literacy education. Students pay particular attention to the effects of culture, social class, and status on the ways language is used, valued, and understood. The Ph.D. program is centered on basic research, in contrast to the Ed.D., which stresses applying and interpreting new discoveries.

The educational psychology focus prepares students to advance psychological theory through empirical inquiry and to apply the results to improving educational practice. The program uses the latest scientific theories to explain how people learn, how they teach others, and how they differ from one another. Students apply the results of this basic psychological research to improving the way people are taught and how they learn. A strong background in research methodology is critical to this endeavor.

Only students who have demonstrated the potential for outstanding research are selected for the program. Among the factors considered for admission are a baccalaureate degree in a relevant area; an undergraduate cumulative grade-point average of at least 3.0; a cumulative graduate grade-point average of at least 3.5 (if applicable); strong performance on the Graduate Record Examination test; a personal statement reflecting prior experience or an interest in independent scholarship; and three letters of recommendation from former professors or employers. In addition, foreign applicants must provide a TOEFLscore indicative of proficiency in English. Additional criteria may be set by each focus track.

Students must complete at least 48 credits of course work, which is distributed as follows: 6 credits in prethesis research in the education concentration (policy, mathematics, literacy, educational psychology); 6 credits in the education core (educational theory, research, and practice); at least 12 credits in research methods, including courses in quantitative and qualitative methodologies; at least 18 credits in the education concentration; and at least 6 credits in the appropriate cognate disciplines. An additional 24 credits of dissertation research are required. Students must maintain a cumulative GPA of at least 3.25 in their doctoral course work. Students may petition the faculty of the Ph.D. in education to transfer up to 24 graduate credits from course work taken elsewhere toward these requirements.

Each Ph.D. student is assigned a research adviser. Students must complete at least two research projects before they are admitted to dissertation candidacy, and they must pass a qualifying examination that is evaluated by a faculty committee in the area of concentration. Students are admitted to dissertation candidacy by the faculty after they have completed successfully the above requirements. In addition, students must provide evidence of successful teaching experience, which is documented by a portfolio submitted for evaluation by the faculty.

Graduate Courses

Courses are open to degree students only.

16:300:501. PROSEMINAR IN EDUCATIONAL THEORIES AND PRACTICE (3)
Examines fundamental issues in education through the reading of major theoretical texts. Explores how those issues inform current research.

16:300:503. PROSEMINAR IN EDUCATIONAL RESEARCH (3)
Explores selected contemporary educational issues through reading research conducted from a variety of methodological perspectives. Explores assumptions through commentaries on the conduct of educational research.

16:300:509. QUALITATIVE RESEARCH METHODS IN EDUCATION I: INTRODUCTION (3)
Introduction to qualitative research techniques, examining their potential and limitations for investigating educational questions and issues. Topics include interviews, field notes, and observations.

16:300:511. QUANTITATIVE RESEARCH METHODS IN EDUCATION I: INTRODUCTION (3)
Introduction to quantitative research techniques, examining their potential and limitations for investigating educational questions and issues. Topics include one- and two-sample tests of hypotheses, analysis of variance, multiple comparison procedures, regression, and effect size.

16:300:513. QUALITATIVE RESEARCH METHODS IN EDUCATION II: DESIGN AND ANALYSIS (3)
Critical examination of the philosophy and techniques of qualitative methods; design of studies and analysis of qualitative data.

16:300:515. QUANTITATIVE RESEARCH METHODS IN EDUCATION II: ANOVA (3)
Critical examination of sampling distributions, analysis of variance models, planned and post hoc comparisons, trend analysis, randomized block designs, within-subject designs, and higher-order factorials.

16:300:516. DEVELOPING A THEORY OF LANGUAGE AND LITERACY EDUCATION (3)
Theoretical perspectives on learning and teaching of the English language arts through critical examination of the works of language and literacy theorists and their personal experiences as learners. Both breadth and depth of exploration are provided through interactions and contributions of several faculty members and students' own investigations into the work of a particular theorist.

16:300:517. QUALITATIVE RESEARCH METHODS IN EDUCATION III: EDUCATIONAL ETHNOGRAPHY (3)
Intensive survey and application of methods and strategies in ethnography available to educational researchers; emphasis on fieldwork employing ethnographic data-gathering techniques that involve participant observation and interview.

16:300:519. QUANTITATIVE RESEARCH METHODS IN EDUCATION III: REGRESSION (3)
Techniques for analyzing data gathered in nonexperimental studies, including matrix algebra, multiple regression, partial and semipartial correlations, variance partitioning, dummy and effect coding, and analysis of covariance.

16:300:520. PROGRAM EVALUATION: AN INTRODUCTION TO METHODS AND PRACTICE (3)
Prerequisites: 16:300:511 or 16:960:532 and permission of instructor.
Topical survey. Activities include hands-on evaluation projects.

16:300:532. LANGUAGE IN EDUCATION: SOCIOCULTURAL THEORY (3)
Prerequisite: Permission of instructor.
The role of language in thinking and social life; variation in language use across social groups and situations.

16:300:533. TOPICS IN LANGUAGE AND LITERACY EDUCATION (3)
Focuses on a particular dimension of theory and research in language and literacy education.

16:300:535. FOUNDATIONS OF LANGUAGE I (3)
Topics include functional motivation of linguistic structure, linguistic sign, phonetics, phonemic and morphemic analyses, word semantics, and correctness.

16:300:536. FOUNDATIONS OF LANGUAGE II (3)
Prerequisite: Permission of instructor.
Contrastive survey of formal and functional grammatical theories relevant to education. History of English, discussion of language change, and a look at comparative and historical linguistics. Examines language and dialect.

16:300:541. INTRODUCTION TO ECONOMICS AND EDUCATION (3)
Economic concepts and their application to education; topics include demand for and supply of education, measuring return on educational investment, productivity and efficiency in the educational sector, and the relationship between human capital and economic growth.

16:300:545. EDUCATIONAL PLANNING AND POLICY DEVELOPMENT (3)
Problem-solving and decision-making models, including studies of values, goal establishment, performance objectives, measurement and assessment techniques, policy development and executive leadership, and information systems; the multicultural nature of society; and the identification of people with special learning needs.

16:300:551. EVALUATION OF EDUCATIONAL AND SOCIAL PROGRAMS (3)
Prerequisite: Permission of instructor.
Evaluation of educational and social institutions, programs, and policies, including the social context of evaluation and the political aspects of conducting educational evaluations. Compares and contrasts evaluation and research. Hands-on data analysis and interpretation using a social policy data set.

16:300:563. RESEARCH INTO THE DEVELOPMENT OF MATHEMATICAL IDEAS (3)
A systematic study of the development of mathematical ideas in children from elementary school through high school. Includes the study and analysis of videotape recordings of children doing mathematics and accompanying data. Students endeavor in some cases to trace the development of mathematical ideas over time.

16:300:581. EDUCATIONAL PSYCHOLOGY I: THEORIES OF DEVELOPMENT (3)
Classical and contemporary theories of human development. Topics include the relations between evolution and development, nature-nurture, individual-society, and biology-culture. The processes through which change occurs over the course of the human life span.

16:300:582. EDUCATIONAL PSYCHOLOGY II: THEORIES OF COGNITION AND INSTRUCTION (3)
Major theories of human learning, cognition, and instruction. Topics include knowledge representation, learning and instructional strategies, domains of application, and research methods.

16:300:591. COGNITIVE DEVELOPMENT (3)
Theory and research in children's intellectual development from birth through adolescence. Neo-Piagetian, information processing, and sociocultural approaches to cognition. Current research, including children's memory development, social cognition, language, problem solving, spatial thinking, and theory of mind. Implications for schooling considered.

16:300:593. COOPERATIVE AND COLLABORATIVE LEARNING (3)
The cognitive and affective consequences of various forms of peer learning.

16:300:595. THE PSYCHOLOGY OF SEX DIFFERENCES (3)
Current psychological theories of sex role development; evidence for and against sex differences throughout the life span; intellectual abilities, achievement, motivation, and behavior; dependence and aggression.

16:300:597. LANGUAGE ACQUISITION (3)
Theories of language acquisition and the functions of language for the child; topics include prelinguistic behavior, the nature of one-word utterances, the acquisition and development of early syntax and semantics, the relation of thought to language, and the development of communication and conversation skills.

16:300:600,601. PRETHESIS RESEARCH (BA,BA)
Students engage in educational research under the supervision of faculty mentors.

16:300:621. SEMINAR IN LITERACY EDUCATION RESEARCH (3)
Prerequisite: Permission of instructor.
Current research in literacy education and related areas of literacy; critical evaluation of published reports; development of mature ideas for writing a proposal, conducting research, and completing a thesis in these areas.

16:300:641. PRODUCTIVITY AND EFFICIENCY IN EDUCATION (3)
How and where the education dollar is spent, as well as how it is raised. Definitions and measures of efficiency and productivity in primary, secondary, and postsecondary education; productivity trends in education, efficient allocation of school resources, school size and productivity, and efficiency implications of school-financing methods.

16:300:643. EDUCATIONAL CHANGE: THEORY AND PRACTICE (3)
Examination of the philosophies underlying recent educational reforms; exploration of implementation and management processes to increase the likelihood of successful outcomes.

16:300:645. EDUCATIONAL POLICY AND POLICY MAKING: THE FEDERAL AND STATE LEVELS (3)
The development, implementation, and effects of federal and state education policies; examples of key policy issues as cases for the exploration of political, policy design, and implementation issues.

16:300:647. HISTORICAL RESEARCH IN EDUCATIONAL POLICY (3)
U.S. historiography and the influence social science has had upon historical research in general and historical research in education in particular.

16:300:661. SEMINAR IN MATHEMATICS EDUCATION RESEARCH (3)
Prerequisite: Practicum or permission of instructor.
Formulation of one or more research question(s); discussion of their theoretical perspectives; design of a pilot study; collection of data; and identification and implementation of a suitable framework for analysis.

16:300:665. TOPICS IN MATHEMATICS EDUCATION (3)
Prerequisites: 16:300:561 and permission of instructor.
Selected topics in the learning and teaching of mathematics.

16:300:681. QUALITATIVE ANALYSIS AND RANKING TECHNIQUES (3)
Prerequisite: 16:300:511 or 16:960:532.
Systematic study of chi-square techniques for analyzing educational data. Distribution-free rank tests for independent and dependent samples, confidence intervals, and measures of association.

16:300:683. APPLIED MULTIVARIATE ANALYSIS (3)
Prerequisite: Permission of instructor.
Survey of multivariate statistical procedures commonly encountered in educational research. Matrix algebra, multivariate analysis of variance, discriminant analysis, exploratory factor analysis, canonical correlations, and log-linear models.

16:300:685. CAUSAL MODELING (3)
Prerequisite: Permission of instructor.
Introduction to structural equation modeling, including latent variables; confirmatory factor analysis; diagnosing model fit and testing alternative models; and multisample designs. Multilevel (or hierarchical) linear models as related to multisample designs (e.g., identifying hierarchical structures, random compared with fixed effects); variance components; and designs with repeated measurements.

16:300:687. ITEM RESPONSE THEORY (3)
Prerequisites: 16:300:511 or 16:960:532 and permission of instructor.
Introduction to item response theory (IRT), which encompasses a group of probabilistic measurement models widely used in standardized testing programs. Foundations and assumptions underlying IRT, comparison of various IRT models, application of IRT to practical testing situations, and implementation of IRT using the BILOG computer program.

16:300:691. COGNITIVE AND MOTIVATIONAL LEARNING STRATEGIES (3)
The theoretical basis for a variety of learning and motivational strategies, assessment of strategies, problems related to learning from different sources of information, individual differences in strategy use.

16:300:695. TOPICS IN EDUCATIONAL PSYCHOLOGY (3)
Prerequisite: Permission of instructor.
Provides advanced doctoral students an opportunity for advanced study of a topic of personal interest within selected areas of psychology or educational statistics and measurement.

16:300:696. TOPICS IN EDUCATIONAL PSYCHOLOGY (3)
Prerequisite: Permission of instructor.
Provides advanced doctoral students an opportunity for advanced study of a topic of personal interest within selected areas of psychology or educational statistics and measurement.

16:300:701,702. RESEARCH IN EDUCATION (BA,BA)

EDUCATIONAL PSYCHOLOGY; EDUCATIONAL THEORY, POLICY, AND ADMINISTRATION; LEARNING AND TEACHING
(See the catalog of the Graduate School of Education for information on the Ed.M., Ed.D., and Ed.S. degrees.)

ELECTRICAL AND COMPUTER ENGINEERING 332

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor David Daut,**
 134 Electrical Engineering Building, Busch Campus
 (732/445-2578)
Email: *daut@ece.rutgers.edu*

Members of the Graduate Faculty

Grigore C. Burdea, *Professor of Electrical and Computer Engineering, SE; Ph.D., New York*
 Robotic complex sensors; assembly with task unknowns; compliance
Michael L. Bushnell, *Professor of Electrical and Computer Engineering, SE; Ph.D., Carnegie Mellon*
 Computer engineering: computer-aided design of VLSI integrated circuit: testing, formal verification, and low-power design
Kin P. Cheung, *Assistant Professor of Electrical and Computer Engineering, SE; Ph.D., New York*
 Nanocrystal arrays, high-K dielectrics, microwave electromechanical resonators, organic electronics, and optics
David G. Daut, *Professor of Electrical and Computer Engineering, SE; Ph.D., Rensselaer Polytechnic Institute*
 Communications and information processing: digital-communication system design and analysis; image coding and transmission
James L. Flanagan, *Board of Governors Professor of Electrical and Computer Engineering, SE; Sc.D., Massachusetts Institute of Technology*
 Speech and image processing; multimedia systems; parallel computing

Zoran R. Gajic, *Associate Professor of Electrical and Computer Engineering, SE; Ph.D., Michigan State*
Systems and control

John K.-J. Li, *Professor of Biomedical Engineering, SE; Ph.D., Pennsylvania*
Circulatory dynamics; instrumentation; physiological control

Yicheng Lu, *Professor of Electrical and Computer Engineering, SE; Ph.D., Colorado*
Metal-semiconductor contacts; thin dielectric files; VLSI processing

Richard Mammone, *Professor of Electrical and Computer Engineering, SE; Ph.D., CUNY*
Digital signal processing: image restoration; speech recognition; medical imaging

Thomas G. Marshall, *Professor of Electrical and Computer Engineering, SE; Ph.D., Chalmers (Gothenburg)*
Digital signal processing: algorithms and specialized signal processing computers

Sigrid R. McAfee, *Associate Professor of Electrical and Computer Engineering, SE; Ph.D., Polytechnic Institute of New York*
Solid-state electronics: deep levels in semiconductors; molecular beam epitaxy and MO-CVD Gallium Arsenide, AlGaAs, and GaAs on silicon

Peter Meer, *Associate Professor of Electrical and Computer Engineering, SE; D.Sc., Technion (Israel)*
Computer vision; image processing; pattern recognition

Evangelia Micheli-Tzanakou, *Professor of Biomedical Engineering, SE; Ph.D., Syracuse*
Visual-pattern recognition; evoked potentials; image quality

Sophocles J. Orfanidis, *Associate Professor of Electrical and Computer Engineering, SE; Ph.D., Yale*
Adaptive signal processing; spectrum estimation; neural networks

Paul Panayotatos, *Professor of Electrical and Computer Engineering, SE; Eng.Sc.D., Columbia*
Solid-state electronics: organic semiconductor p-n heterojunction solar cells

Narindra N. Puri, *Professor of Electrical and Computer Engineering, SE; Ph.D., Pennsylvania*
Systems and controls: optimal adaptive control systems

Lawrence R. Rabiner, *Professor of Electrical and Computer Engineering, SE; Ph.D., Massachusetts Institute of Technology*
Digital signal and speech processing, communications, and networking

Dipankar Raychaudhuri, *Professor of Electrical and Computer Engineering, SE; Ph.D., SUNY (Stony Brook)*
Architecture, design, and prototyping of future computing systems, both wired and wireless; mobile computing

Christopher Rose, *Professor of Electrical and Computer Engineering, SE; Ph.D., Massachusetts Institute of Technology*
Dynamic behavior of multielement networks: communications and neural

Peddapullaiah Sannuti, *Professor of Electrical and Computer Engineering, SE; Ph.D., Illinois*
Communication and control systems: singular perturbation analysis of Kalman filter with weak measurement noise

George K. Shoane, *Professor of Biomedical Engineering, SE; Ph.D., California (Berkeley)*
Binocular vision; vergence; accommodation model; amblyopia

Deborah E. Silver, *Associate Professor of Electrical and Computer Engineering, SE; Ph.D., Princeton*
Visualization; computer graphics; computational geometry; numerical analysis

Edwardo D. Sontag, *Professor of Mathematics, FAS–NB; Ph.D., Florida*
Linear and nonlinear control; neural networks; feedback design

Predrag Spasojevic, *Assistant Professor of Electrical and Computer Engineering, SE; Ph.D., Texas A&M*
Wireless communications, sequence estimation, multiple access, and multiuser detection

Joseph Wilder, *Research Professor of Electrical and Computer Engineering, SE; Ph.D., Pennsylvania*
Image processing; pattern recognition; machine vision

Roy D. Yates, *Associate Professor of Electrical and Computer Engineering, SE; Ph.D., Massachusetts Institute of Technology*
Data networks; queuing; stochastic processes

Jian H. Zhao, *Professor of Electrical and Computer Engineering, SE; Ph.D., Carnegie Mellon*
Semiconductor heteroepitaxial growth and optoelectronic devices

Associate Members of the Graduate Faculty

Vishwani D. Agrawal, *Visiting Professor of Electrical and Computer Engineering, SE; Ph.D., Illinois*
VLSI circuit spectral testing, built-in self-test; hardware verification

Michael F. Caggiano, *Assistant Professor of Electrical and Computer Engineering, SE; Ph.D., California (Los Angeles)*
High-performance and microwave IC device packaging

Kristin Dana, *Assistant Professor of Electrical and Computer Engineering, SE; Ph.D., Columbia*
Computer vision and computer graphics, surface modeling and texture analysis

Stanley M. Dunn, *Professor of Biomedical Engineering, SE; Ph.D., Maryland*
Computer engineering: image processing; pattern recognition; machine vision; software engineering

James G. Evans, *Research Professor of Electrical and Computer Engineering, SE; Ph.D., New York*
Radio techniques to minimize system cost and signal-processing complexity

Narayan B. Mandayam, *Professor of Electrical and Computer Engineering, SE; Ph.D., Rice*
Communication theory; spread spectrum; wireless systems; multiaccess protocols

Ivan Marsic, *Associate Professor of Electrical and Computer Engineering, SE; Ph.D., Rutgers*
Distributed systems for collaborative/information processing and learning; image reconstruction; machine vision

Manish Parashar, *Assistant Professor of Electrical and Computer Engineering, SE; Ph.D., Syracuse*
Parallel and distributed computing; software engineering

Michael A. Parker, *Assistant Professor of Electrical and Computer Engineering, SE; Ph.D., Syracuse*
Solid-state electronics; optical interconnects and switching; nanoscale devices and signals; quantum vacuum effects for optoelectronics; semiconductor lasers fabrication

Steve Petrucelli, *Professor of Biomedical Engineering, SE; Ph.D., Rutgers*
Electronics: pulse circuits design and analysis; analytical instrumentation

Kuang Sheng, *Assistant Professor of Electrical and Computer Engineering, SE; Ph.D., Heriot-Watt*
Solid-state power ICs, electronics, and devices; novel devices and SOI technology

Wade Trappe, *Assistant Professor of Electrical and Computer Engineering, SE; Ph.D., Maryland*
Multimedia and multicast information security, signal, image, and video processing

Yangyong Zhang, *Assistant Professor of Electrical and Computer Engineering, SE; Ph.D., Pennsylvania State*
Operating systems, parallel, and distributed systems; networking

Programs

The graduate program in electrical and computer engineering has facilities for education and research in the following areas: computer engineering, control systems, digital signal processing, communications, and solid-state electronics. Computer engineering involves the architecture and design of computing machines, information processing, and software engineering. Control systems is concerned with the design, analysis, simulation, and mathematical modeling of systems to ensure that an automatic process (e.g., robot or spacecraft) meets and maintains certain criteria. Digital-signal processing deals with discrete-time information processing, digital-filter design, spectral analysis, and special-purpose signal processors. Electrical communications systems analysis and design involves the study of source and channel encoding, analog and digital modulation methods, information theory, and telecommunication networks. Wireless communications and wireless information networks focus on analysis, measurement, and simulations. Solid-state electronics encompasses microwave switching devices, semiconductor lasers, electro-optical modulation, solar cells, integrated circuits, and the characterization of semiconductor materials and devices. This broad base of research areas provides students with the flexibility to create individualized programs of study.

Students with a B.S. degree from an accredited electrical engineering school may apply for direct admission to the graduate program. Students with backgrounds in other concentrations, such as physics, mathematics, and computer science, or in engineering programs other than electrical engineering, are required to pass certain prerequisite undergraduate courses in electrical engineering. Students from electrical technology programs may be required to take several undergraduate courses in addition to the graduate program requirements. The Graduate Record Examination general test is required for admission to the program.

Masters of science degree candidates may elect either a thesis or nonthesis option. The thesis option consists of 24 credits of course work, 6 credits of research in a specialized area, and a final thesis presentation. In the nonthesis option, a candidate must complete 30 credits of course work, pass a written comprehensive examination, and submit a satisfactory tutorial paper. The M.S. comprehensive examination is given twice a year.

Requirements for the M.S. degree may be satisfied for all options in a part-time evening program designed specifically for students employed in industry and other students whose obligations preclude full-time study. Admission and academic standards for part-time students are the same as for full-time students. This

arrangement makes it possible for students to combine day and evening schedules simultaneously or at different periods in their academic careers. Students completing the requirements for the M.S. degree or the Ph.D. degree also are eligible for the Certificate in Wireless Communications (see the Wireless Communications subject heading for further information and requirements for this certificate).

Admission into the Ph.D. program requires an M.S. degree in electrical engineering. Applicants having an M.S. degree in a closely related discipline may be admitted into the doctoral program provided their preparation has no significant deficiencies. Students are considered to be Ph.D. candidates after satisfactory completion of the qualifying examination and presentation of their dissertation topic. The Ph.D. qualifying examination normally consists of four preliminary oral exams, a major oral exam, and presentation of a thesis proposal. The oral qualifying examination is generally given twice a year. A Ph.D. candidate, in conjunction with an adviser, is required to select a dissertation committee, submit a plan of study, and present orally a dissertation proposal.

Minimum requirements for the Ph.D. degree include 48 credits beyond the baccalaureate degree in courses approved by the dissertation adviser. These 48 credits are in addition to 24 credits of dissertation research beyond the M.S. degree. A public defense serves as the final Ph.D. dissertation examination. There is no foreign language requirement. The residence requirement depends upon the area of specialization. The master of philosophy degree is available to doctoral candidates.

Graduate Courses

16:332:501. (F) SYSTEM ANALYSIS (3)
Fundamental system concepts, solution of linear differential and difference equations. Transform methods involving Fourier and Laplace transforms, double-sided Laplace transforms, Z-transforms, Hilbert transforms, convolution in time and frequency domain. Complex variables and application of Residue Theorem for transform inversion. Review of matrix algebra involving similarity transformations. Cayley-Hamilton theorem; state space concepts, controllability, observability, minimal realization.

16:332:503,504. ELECTRIC NETWORK THEORY I,II (3,3)
Prerequisite: 16:332:501.
Network synthesis of driving point and transfer impedances using Foster, Bott-Duffin, Brune, and Darlington techniques; topological methods for analysis of active and passive networks; flow-graph techniques; state-space formulation of general networks; computer-aided network design.

16:332:505. (S) CONTROL SYSTEM THEORY I (3)
Prerequisite: 16:332:501.
Transform theory and transfer function concepts; Nyquist and Bode plots. Nyquist and Hurwitz criterion of stability and design techniques involving Hall and Nichols charts. Design of compensating networks via root locus technique. State-space formulation of control systems. Definition of stability in time domain for general systems; methods of finding stability constraints. Discrete systems; z-transforms; difference equations; stability criterion.

16:332:506. (F) CONTROL SYSTEM THEORY II (3)
Prerequisite: 16:332:505.
Review of state-space techniques; transfer function matrices; concepts of controllability, observability, and identifiability. Identification algorithms for multivariable systems; minimal realization of a system and its construction from experimental data. State-space theory of digital systems. Design of a three-mode controller via spectral factorization.

16:332:508. (S) SAMPLED DATA CONTROL SYSTEMS (3)
Prerequisite: 16:332:505.
Methods of analysis and synthesis of discrete-time systems; various transformations and semigraphical techniques applied to both digital and digitally controlled continuous processes with deterministic and/or random signals.

16:332:510. (S) SYNTHESIS OF OPTIMUM CONTROL SYSTEMS (3)
Prerequisites: 16:332:505, 506.
Formulation of both deterministic and stochastic optimal control problems. Various performance indices; calculus of variations; derivation of Euler-Lagrange and Hamilton-Jacobi equations and their connection to two-point boundary value problems, linear regulator and the Riccati equations. Pontryagin's maximum principle; its application to minimum time, minimum fuel, and bang-bang control. Numerical techniques for Hamiltonian minimization. Bellman dynamic programming; maximum principle and invariant imbedding.

16:332:512. (S) NONLINEAR AND ADAPTIVE CONTROL THEORY (3)
Prerequisite: 16:332:505.
Nonlinear servo systems; general nonlinearities; describing function and other linearization methods; phase-plane analysis and Poincare theorems. Liapunov's method of stability; Popov criterion; circle criterion for stability. Adaptive and learning systems; identification algorithms and observer theory; input adaptive, model-reference adaptive, and self-optimizing systems. Estimation and adaptive algorithms via stochastic approximation. Multivariable systems under uncertain environment.

16:332:514. (S) STATISTICAL DESIGN OF AUTOMATIC CONTROL SYSTEMS (3)
Prerequisite: 16:332:505.
Response of linear and nonlinear systems to random inputs. Determination of statistical character of linear and nonlinear filter outputs. Correlation functions; performance indices for stochastic systems; design of optimal physically realizable transfer functions. Wiener-Hopf equations; formulation of the filtering and estimation problems; Wiener-Kalman filter. Instabilities of Kalman filter and appropriate modifications for stable mechanization. System identification and modeling in presence of measurement noise.

16:332:519. ADVANCED TOPICS IN SYSTEMS ENGINEERING (3)
Prerequisite: Permission of instructor.
Advanced study of various aspects of automatic control systems. Possible topics include identification, filtering, optimal and adaptive control, learning systems, digital and sampled data implementations, singular perturbation theory, large-scale systems, game theory, geometric control theory, and control of large flexible structures. Topics vary from year to year.

16:332:521. (F) DIGITAL SIGNALS AND FILTERS (3)
Corequisite: 16:332:501.
Sampling and quantization of analog signals; z-transforms; digital filter structures and hardware realizations; digital filter design methods; DFT and FFT methods and their application to fast convolution and spectrum estimation; introduction to discrete-time random signals.

16:332:525. (F) OPTIMUM SIGNAL PROCESSING (3)
Prerequisite: 16:332:521 or permission of instructor.
Block processing and adaptive signal processing techniques for optimum filtering, linear prediction, signal modeling, and high-resolution spectral analysis. Lattice filters for linear prediction and Wiener filtering. Levinson and Schur algorithms and their split versions. Fast Cholesky factorizations. Periodogram and parametric spectrum estimation and superresolution array processing. LMS, RLS, and lattice adaptive filters and their applications. Adaptation algorithms for multilayer neural nets.

16:332:526. (S) ROBOTIC SYSTEMS ENGINEERING (3)
Introduction to robotics; robot kinematics and dynamics. Trajectory planning and control. Systems with force, touch, and vision sensors. Telemanipulation. Programming languages for industrial robots. Robotic simulation examples.

16:332:527. (S) Digital Speech Processing (3)
Prerequisite: 16:332:521.

Acoustics of speech generation; perceptual criteria for digital representation of audio signals; signal processing methods for speech analysis; waveform coders; vocoders; linear prediction; differential coders (DPCM, delta modulation); speech synthesis; automatic speech recognition; voice-interactive information systems.

16:332:529. (S) Image Coding and Processing (3)
Prerequisites: 16:332:521, 16:642:550. Recommended: 16:332:535.

Visual information, image restoration, coding for compression and error control, motion compensation, advanced television.

16:332:533. (S) Computational Methods for Signal Recovery (3)
Prerequisites: 16:332:521, 541.

Linear shift varying systems; discrete constrained estimation techniques; applications in image restoration; image reconstruction; spectral estimation and channel equalization using decision feedback.

16:332:535. (F) Multiresolution Signal Processing Algorithms (3)
Prerequisite: 16:332:521 or permission of instructor. Corequisite: 16:642:550.

Algebraic models and algorithms, sampling lattices, multi-resolution transforms, filters, rate conversion, deconvolution and projection.

16:332:539. Advanced Topics in Digital Signal Processing (3)
Prerequisite: Permission of instructor.

Emphasis on current research areas. Advanced treatment of such topics as digital filter design, digital filtering of random signals, discrete spectral analysis methods, and digital signal processor architectures.

16:332:541. (F) Stochastic Signals and Systems (3)
Corequisite: 16:332:501.

Axioms of probability; conditional probability and independence; random variables and functions thereof; mathematical expectation; characteristic functions; conditional expectation; Gaussian random vectors; mean square estimation; convergence of a sequence of random variables; laws of large numbers and Central Limit Theorem; stochastic processes, stationarity, autocorrelation, and power spectral density; linear systems with stochastic inputs; linear estimation; independent increment, Markov, Wiener, and Poisson processes.

16:332:542. (S) Information Theory and Coding (3)
Prerequisite: 16:332:541.

Noiseless channels and channel capacity; entropy, mutual information, Kullback-Leibler distance, and other measures of information; typical sequences, asymptotic equipartition theorem; prefix codes, block codes, data compression, optimal codes, Huffman, Shannon-Fano-Elias, arithmetic coding; memoryless channel capacity, coding theorem and converse; Hamming, BCH, cyclic codes; Gaussian channels and capacity; coding for channels with input constraint; introduction to source coding with a fidelity criterion.

16:332:543. (F) Communication Networks I (3)

Introduction to telephony and integrated networks. Multiplexing schematics. Circuit and packet switching networks. Telephone switches and fast packet switches. Teletraffic characterization. Delay and blocking analysis. Queuing network analysis.

16:332:544. (S) Communication Networks II (3)
Prerequisite: 16:332:543.

Network and protocol architectures. Layered-connection management, including network design, path dimensioning, dynamic routing, flow control, and random-access algorithms. Protocols for error control, signaling, addressing, fault management, and security control.

16:332:545. (S) Communication Theory (3)
Prerequisite: 16:332:541.

Orthonormal expansions, effect of additive noise in electrical communications, vector channels, waveform channels, matched filters, band width, and dimensionality. Optimum receiver structures, probability of error, bit and block signaling, introduction to coding techniques.

16:332:546. (S) Wireless Communications Technologies (3)
Prerequisite: 16:332:545.

Propagation models and modulation techniques for wireless systems, receivers for optimum detection on wireless channels, effects of multiple access and intersymbol interference, channel estimation, TDMA and CDMA cellular systems, radio resource management, mobility models.

16:332:547. (F) Digital Communications I (3)
Prerequisite: 16:332:545.

Functional characterization of digital signals and transmission facilities, band-limited and time-limited signals, modulation and demodulation techniques for digital signals, error probability, intersymbol interference and its effects, equalization and optimization of baseband binary and M-ary signaling schemes. Application to satellite and space communication systems emphasized.

16:332:548. (S) Digital Communications II (3)
Prerequisite: 16:332:547. Corequisite: 16:332:542.

Continuation of 16:332:547. Application of information-theoretic principles to communication system analysis and design. Source and channel-coding considerations, rudiments of rate-distortion theory. Probabilistic error-control coding impact on system performance. Introduction to various channel models of practical interest, spread spectrum communication fundamentals. Current practices in modern digital communication system design and operation.

16:332:549. (S) Detection and Estimation Theory (3)
Prerequisite: 16:332:541.

Statistical decision theory, hypothesis testing, detection of known signals and signals with unknown parameters in noise, receiver performance, and error probability; applications to radar and communications. Statistical estimation theory, performance measures and bounds, efficient estimators. Estimation of unknown signal parameters, optimum demodulation, applications. Linear estimation, Wiener filtering, Kalman filtering.

16:332:551. (S) Fading Communication Channels (3)
Prerequisite: 16:332:548.

Characterization and modeling of fading and/or dispersive channels, analog and digital communication system performance, diversity reception, optimum demodulators for channel memory effects. Applications include troposcatter, HF, atmospheric scattering, and optical channels. Emphasis on analysis of space communication and optical communication system performance.

16:332:555. (F) Microwave Circuits: Design and Engineering (3)
Prerequisite: 16:332:580 or equivalent.

Overview of modern microwave engineering, including transmission line, network analysis, integrated circuits, diodes, amplifier and oscillator design.

16:332:556. (S) Microwave Systems (3)
Prerequisite: 16:332:580 or equivalent.

Microwave subsystems, including front-end and transmitter components, antennas, radar, terrestrial communications, and satellites.

16:332:559. Advanced Topics in Communications Engineering (3)
Prerequisite: Permission of instructor.

Topics such as source and channel coding, modern modulation techniques, telecommunication networks, and information processing.

16:332:560. (F) COMPUTER GRAPHICS (3)
Computer-display systems, algorithms, and languages for interactive graphics. Vector, curve, and surface-generation algorithms. Hidden-line and hidden-surface elimination. Free-form curve and surface modeling. High-realism image rendering.

16:332:561. (F) MACHINE VISION (3)
Prerequisite: 16:332:501.
Image processing and pattern recognition. Principles of image understanding. Image formation, boundary detection, region growing, texture, and characterization of shape. Shape from monocular cues, stereo, and motion. Representation and recognition of 3-D structure.

16:332:562. (S) VISUALIZATION AND ADVANCED COMPUTER GRAPHICS (3)
Prerequisite: 16:332:560.
Advanced visualization techniques, including volume representation, volume rendering, ray tracing, composition, surface representation, advanced data structures. User interface design, parallel and object-oriented graphic techniques, advanced modeling techniques.

16:332:563. (F) COMPUTER ARCHITECTURE I (3)
Fundamentals of computer architecture using quantitative and qualitative principles. Instruction set design with examples and measurements of use, basic processor implementation: hardwired logic and microcode, pipelining; hazards and dynamic scheduling, vector processors, memory hierarchy; caching, main memory and virtual memory, input/output, and introduction to parallel processors; SIMD and MIMD organizations.

16:332:564. (S) COMPUTER ARCHITECTURE II (3)
Prerequisite: 16:332:563.
Advanced hardware and software issues in mainstream computer architecture design and evaluation. Register architecture and design, instruction sequencing and fetching, cross-branch fetching, advanced software pipelining, acyclic scheduling, execution efficiency, predication analysis, speculative execution, memory access ordering, prefetch and preloading, cache efficiency, low-power architecture, and issues in multiprocessors.

16:332:565. (F) NEUROCOMPUTER SYSTEM DESIGN (3)
Prerequisite: 16:332:563.
Principles of neural-based computers, data acquisition, hardware architectures for multilayer, tree, and competitive learning neural networks, applications in speech recognition, machine vision, target identification, and robotics.

16:332:566. (S) PARALLEL AND DISTRIBUTED COMPUTING (3)
Prerequisites: 16:332:563 and 564.
Introduction to parallel and distributed computing technologies, including systems, architectures, programming models, languages, and software tools. Parallelization and distribution models; parallel architectures; cluster and networked metacomputing systems; parallel/distributed programming; applications; and performance analysis.

16:332:567. (F) SOFTWARE ENGINEERING (3)
Overview of software development process. Formal techniques for requirements analysis, system specification, and system testing. Distributed systems, system security, and system reliability. Software models and metrics. Case studies.

16:332:568. (S) SOFTWARE ENGINEERING OF WEB APPLICATIONS (3)
Prerequisite: 16:332:567.
Program-development and software-design methodologies. Abstract data types, information hiding, program documentation. Program testing and reusability. Axiomatic and functional models. Case studies.

16:332:569. (F) DATABASE SYSTEM ENGINEERING (3)
Relational data model, relational database management system, relational query languages, parallel database systems, database computers, and distributed database systems.

16:332:570. (S) ROBUST COMPUTER VISION (3)
Prerequisite: 16:332:561.
A toolbox of advanced methods for computer vision using robust estimation, clustering, probabilistic techniques, invariance. Applications include feature extraction, image segmentation, object recognition, and 3-D recovery.

16:332:571. (S) VIRTUAL REALITY TECHNOLOGY (3)
Prerequisite: 16:332:560.
Introduction to virtual reality. Input/output tools. Computing architecture. Modeling. Virtual reality programming. Human factors. Applications. Future systems.

16:332:573. (S) DATA STRUCTURES AND ALGORITHMS (3)
Programming in C and C++. Data structures and algorithms commonly used in engineering software applications. Stacks, linked lists, queues, sorting, trees, search trees, hashing, heaps, graphs, and graph algorithms. Computation models and complexity.

16:332:574. (F) COMPUTER-AIDED DIGITAL VLSI DESIGN (3)
Advanced computer-aided digital VLSI chip design, CMOS technology, domino logic, precharged busses, case studies of chips, floor planning, layout synthesis, routing, compaction circuit extraction, multilevel circuit simulation, circuit modeling, fabrication processes, and other computer-aided design tools.

16:332:575. (S) VLSI ARRAY PROCESSORS (3)
Prerequisite: 16:332:574.
VLSI technology and algorithms; systolic and wavefront-array architecture; bit-serial pipelined architecture; DSParchitecture; transputer; interconnection networks; wafer-scale integration; neural networks.

16:332:576. (S) TESTING OF ULTRA LARGE SCALE CIRCUITS (3)
Prerequisite: 16:332:563.
Algorithms for test-pattern generation for combinational, sequential, and CMOS circuits. Design of circuits for easy testability. Design of built-in self-testing circuits.

16:332:577. (S) ANALOG AND LOW-POWER DIGITAL VLSI DESIGN (3)
Prerequisite: 16:332:574.
Transistor design and chip layout of commonly used analog circuits, such as OPAMPs, A/D, and D/Aconverters; sample-and-hold circuits; filters; modulators; phase-locked loops; and voltage-controlled oscillators. Low-power design techniques for VLSI digital circuits, and system-on-a-chip layout integration issues between analog and digital cores.

16:332:579. ADVANCED TOPICS IN COMPUTER ENGINEERING (3)
Permission of instructor.
In-depth study of topics pertaining to computer engineering, such as microprocessor system design; fault-tolerant computing; real-time system design. Subject areas vary from year to year.

16:332:580. (F) ELECTRIC WAVES AND RADIATION (3)
Prerequisite: Elementary electromagnetics.
Static-boundary value problems, dielectrics, wave equations, propagation in lossless and lossy media, boundary problems, waveguides and resonators, radiation fields, antenna patterns and parameters, arrays, transmit-receive systems, antenna types.

16:332:581. (F) INTRODUCTION TO SOLID-STATE ELECTRONICS (3)
Introduction to quantum mechanics; WKB method; perturbation theory; hydrogen atom; identical particles; chemical bonding; crystal structures; statistical mechanics; free-electron model; quantum theory of electrons in periodic lattices.

16:332:583. (F) Semiconductor Devices I (3)
Charge transport; diffusion and drift current; injection, lifetime, recombination, and generation processes; p-n junction devices; transient behavior; FETs, I-V, and frequency characteristics; MOS devices C-V, C-f, and I-V characteristics; operation of bipolar transistors.

16:332:584. (S) Semiconductor Devices II (3)
Prerequisite: 16:332:583.
Review of microwave devices, O- and M-type devices, microwave diodes, Gunn, IMPATT, TRAPATT, scattering parameters and microwave amplifiers, heterostructures and III-V compound-based BJTs and FETs.

16:332:587. (F) Transistor Circuit Design (3)
Design of discrete transistor circuits; amplifiers for L.F., H.F., tuned, and power applications biasing; computer-aided design; noise; switching applications; operational amplifiers; linear circuits.

16:332:588. (S) Integrated Transistor Circuit Design (3)
Prerequisite: 16:332:587.
Design of digital integrated circuits based on NMOS, CMOS, bipolar, BiCMOS, and GaAs FETs; fabrication and modeling; analysis of saturating and nonsaturating digital circuits, sequential logic circuits, semiconductor memories, gate arrays, PLA and GaAs LSI circuits.

16:332:590. (S) Integrated Circuits (3)
Prerequisite: 16:332:583.
Basic processing of ICs, diffusion, and ion implantation; isolation methods; integrated resistors and inductors; junction capacitors; diodes, FET, MOS and bipolar transistors; thermal effects and basic linear integrated circuits.

16:332:591. (F) Optoelectronics I (3)
Prerequisites: 16:332:580, and 581 or 583.
Principles of laser action, efficiency, CW and pulse operation, mode locking, output coupling, equivalent circuits, gaseous and molecular lasers, solid-state lasers, single and double heterojunction lasers, different geometries, fabrication, degradation, and application to holography, communication, medicine, and fusion.

16:332:592. (S) Optoelectronics II (3)
Prerequisite: 16:332:591.
Photodetectors, including avalanche, Schottky, p-i-n, and multi element detectors; display devices, including semiconductor, liquid crystals, electrochromics, electroluminescent panels; optoisolaters; fiber optics communication and optoelectronics in information systems.

16:332:593. (S) Electronics Packaging (3)
Prerequisites: 16:332:580 and 587.
Overview of microelectronic packaging. Calculation of resistance, inductance, capacitance, and RF skin effects. Interconnect-transfer functions and signal integrity. Packaging analysis and simulations of power, ground, and cross-talk noise.

16:332:594. (F) Solar Cells (3)
Prerequisite: 16:332:583 or equivalent.
Photovoltaic material and devices, efficiency criteria, Schottky barrier, p-n diode, heterojunction and MOS devices, processing technology, concentrator systems, power system designs, and storage.

16:332:596. (S) Semiconductor Surfaces (3)
Surface composition and structure of semiconductor, ultrahigh vacuum technology, Auger electron spectroscopy, low-energy electron diffraction, photoemission spectroscopy, secondary ion mass-spectroscopy.

16:332:597. (S) Material Aspects of Semiconductors (3)
Prerequisite: 16:332:581.
Preparation of elemental and compound semiconductors. Bulk crystal growth techniques. Epitaxial growth techniques. Impurities and defects and their incorporation. Characterization techniques to study the structural, electrical, and optical properties.

16:332:599. Advanced Topics in Solid-State Electronics (3)
Prerequisite: Permission of instructor.
Topics vary and include semiconductor materials, surfaces, and devices; optoelectronic devices; sensors; photovoltaics; fiber optics; and analog/digital circuit design.

16:332:601,602. Special Problems (BA,BA)
Prerequisite: Permission of instructor.
Investigation in selected areas of electrical engineering.

16:332:618. Seminar in Systems Engineering (1)
Presentation involving current research given by advanced students and invited speakers. Term papers required.

16:332:638. Seminar in Digital Signal Processing (1)
Presentation involving current research given by advanced students and invited speakers. Term papers required.

16:332:658. Seminar in Communications Engineering (1)
Presentation involving current research given by advanced students and invited speakers. Term papers required.

16:332:678. Seminar in Computer Engineering (1)
Presentation involving current research given by advanced students and invited speakers. Term papers required.

16:332:698. Seminar in Solid-State Electronics (1)
Presentation involving current research given by advanced students and invited speakers. Term papers required.

16:332:699. Colloquium in Electrical and Computer Engineering (0)
Eminent figures in electrical and computer engineering invited as guest lecturers on current research topics and major trends. Each full-time M.S. and Ph.D. student must take the colloquium, and each must have 80 percent attendance records. M.S. students must take the colloquium for two terms but get 0 credits. Ph.D. students must take the colloquium for four terms but get 0 credits.

16:332:701,702. Research in Electrical Engineering (3,3)

ENGINEERING GEOPHYSICS

Program Offered: **Certificate in Engineering Geophysics**
Director of the Certificate Program: **Professor Peter A. Rona, Institute of Marine and Coastal Sciences, Marine Sciences Building, Cook Campus (732/932-6555, ext. 241)**
Email: *rona@imcs.rutgers.edu*

Participating Faculty

David G. Daut, *Electrical and Computer Engineering*
Daniel Giménez, *Environmental Sciences*
Scott M. Glenn, *Oceanography*
Nenad Gucunski, *Civil and Environmental Engineering*
Dale B. Haidvogel, *Oceanography*
Lisa C. Klein, *Ceramic and Materials Engineering*
Ali Maher, *Civil and Environmental Engineering*
Adrian Mann, *Ceramic and Materials Engineering*
Monica Mazurek, *Civil and Environmental Engineering*
James R. Miller, *Oceanography*
Andrew N. Norris, *Mechanical and Aerospace Engineering*
Henrik Pedersen, *Chemical and Biochemical Engineering*
Richard E. Riman, *Ceramic and Materials Engineering*
Alan Robock, *Environmental Sciences*

Peter A. Rona, *Geological Sciences, Oceanography*
Robert E. Sheridan, *Geological Sciences*
Deborah Silver, *Electrical and Computer Engineering*
Peter F. Strom, *Environmental Sciences*
Norman Zabusky, *Mechanical and Aerospace Engineering*

Certificate Program

Engineering geophysics is a new field that applies geophysics to engineering with reference to a broad spectrum of societal and industrial environmental problems. Students take selected courses from graduate programs in engineering, geological sciences, and oceanography in conjunction with their M.S. and Ph.D. programs. The certificate program offers students in engineering and the geological and oceanographic sciences a chance to broaden and strengthen their backgrounds, with the emphasis on environmental applications.

The program encompasses multidisciplinary field, laboratory, and modeling studies using state-of-the-art geophysical, engineering, and oceanographic practice and theory. A comprehensive suite of research facilities is available for these studies, including geophysical, engineering, and marine field and laboratory instrumentation. For students of engineering, the program provides training in geophysical methods and a geological and marine context for engineering applications. For students of geological and oceanographic sciences, the program provides reciprocal training and training in engineering subjects that enhance their capabilities. This multidisciplinary training can provide a competitive edge in research and in the job market.

Certificate Requirements

Students must fulfill all degree requirements in their major programs of study. M.S. and Ph.D. students in the certificate program will take three courses in the participating graduate programs outside the graduate program of their degree, including at least one course in geophysics. The selection of courses will be determined by each graduate program and tailored to the individual needs and directions of the students.

Research Facilities

Equipment and Laboratories

Geophysical Instrumentation. **Shallow seismic system (marine and terrestrial), magnetometer, gravity meter, gamma-ray spectrometer**

Equipment for Field Seismic Testing. **Crosshole, seismic cone, spectral analysis of surface waves, and laboratory evaluation of dynamic soil and rock properties (cyclic triaxial, resonant column, torsional shear, model testing in a soil bin)**

Laboratory for Visiometrics and Modeling. **Center for Advanced Information Processing, Rutgers–New Brunswick**

Rutgers University Marine Field Station. **Tuckerton, New Jersey**

Long-Term Ecosystem Observatory **at 15 meters depth (LEO-15)**

Graduate Courses

Ceramic and Materials Engineering

16:150:501   Advanced Powder Processing I (3)
16:150:510   Physical Properties of Crystals (3)
16:150:526   Crystal Chemistry of Ceramic Materials (3)
16:150:532   Kinetics of Materials Systems (3)

Chemical and Biochemical Engineering

16:155:501   Advanced Transport Phenomena I–Fluid Mechanics (3)
16:155:502   Advanced Transport Phenomena II–Heat and Mass Transfer (3)
16:155:506   Fluid Particles and Granular Flow (3)
16:155:582   Fundamentals of Contaminant Mass Transfer (3)

Civil and Environmental Engineering

16:180:565   Biogeochemical Engineering (3)
16:180:566   Sediment Transport (3)
16:180:574   Groundwater Engineering I (3)
16:180:576   Groundwater Engineering II (3)
16:180:578   Soil Dynamics (3)
16:180:590   Coastal Engineering (3)

Electrical and Computer Engineering

16:332:501   System Analysis (3)
16:332:521   Digital Signals and Filters (3)
16:332:525   Optimum Signal Processing (3)
16:332:529   Image Coding and Processing (3)
16:332:533   Computational Methods for Signal Recovery (3)
16:332:560   Computer Graphics (3)
16:332:561   Machine Vision (3)
16:332:562   Visualization and Advanced Computer Graphics (3)
16:332:570   Robust Computer Vision (3)

Geological Sciences

16:460:505   Sedimentary Geology (3)
16:460:507   Geodynamics (3)
16:460:511   Petrology (3)
16:460:525   Marine Sedimentology (3)
16:460:541   Marine Geology (3)
16:460:555   Geophysics I (3)
16:460:556   Geophysics II (3)

Mechanical and Aerospace Engineering

16:650:530   Fluid Mechanics I (3)
16:650:570   Conduction Heat Transfer (3)
16:650:578   Convection Heat Transfer (3)
16:650:630   Fluid Mechanics II (3)
16:650:640   Acoustics (3)
16:650:650   Theory of Elasticity (3)
16:650:662   Advanced Stress Waves in Solids (3)

Oceanography

16:712:501   Physical Oceanography (3)
16:712:545   Dynamics of Waves, Currents, and Sediment Transport on the Continental Shelf (3)
16:712:603   Numerical Modeling of the Atmosphere and Ocean (3)

ENGLISH, LITERATURES IN
(English 350, Composition Studies 352)

Degree Program Offered: **Doctor of Philosophy**
Certificate Program Offered: **Certificate in the Teaching of Writing**
Director of Graduate Program: **Professor Myra Jehlen**
Director of Certificate Program: **Professor Richard E. Miller, Murray Hall, College Avenue Campus (732/932-7674)**

Members of the Graduate Faculty

Derek Attridge, *Distinguished Visiting Professor of English, FAS–NB; Ph.D., Cambridge*
Literary theory; modernism; poetics
Louise K. Barnett, *Professor of English, FAS–NB; Ph.D., Bryn Mawr*
Nineteenth- and 20th-century American novel; 19th-century American culture; women's studies
Emily Bartels, *Associate Professor of English, FAS–NB; Ph.D., Harvard*
Renaissance dramatic literature; colonialist discourse
John H. Belton, *Professor of English, FAS–NB; Ph.D., Harvard*
Cinema studies; cultural studies
Wesley C. Brown, *Professor of English, FAS–NB; M.A., CUNY*
Nineteenth- and 20th-century American literature; modern drama
Matthew Buckley, *Assistant Professor of English, FAS–NB; Ph.D., Columbia*
Eighteenth-, 19th-, and 20th-century drama
Abena P.A. Busia, *Associate Professor of English, FAS–NB; D.Phil., Oxford*
African-American and African diaspora literature
Christine Chism, *Associate Professor of English, FAS–NB; Ph.D., Duke*
Medieval literature, medieval drama, women's studies, cultural studies, historiography

Ed Cohen, *Associate Professor of English, FAS–NB; Ph.D., Stanford*
Literary and social theory; gay and gender studies; late Victorian culture

Ann Baynes Coiro, *Associate Professor of English, FAS–NB; Ph.D., Maryland*
Renaissance and 17th-century literature; women's studies

Harriet A. Davidson, *Associate Professor of English, FAS–NB; Ph.D., Vanderbilt*
Modern and contemporary poetry; critical theory

Marianne DeKoven, *Professor of English, FAS–NB; Ph.D., Stanford*
Modernism; women's studies

Elin Diamond, *Professor of English, FAS–NB; Ph.D., California (Davis)*
Drama and dramatic theory; feminist and literary theory

Richard Dienst, *Associate Professor of English, FAS–NB; Ph.D., Duke*
Cultural theory; media studies

William C. Dowling, *Professor of English, FAS–NB; Ph.D., Harvard*
Eighteenth-century literature; colonial American literature and literature of the early American republic; critical theory

Brent Edwards, *Associate Professor of English, FAS–NB; Ph.D., Columbia*
African-American literature; Francophone literature; 20th-century poetry of the Americas; music and literature; cultural studies

Katherine Ellis, *Associate Professor of English, FAS–NB; Ph.D., Columbia*
Women's studies; 18th-century fiction

David Eng, *Associate Professor of English, FAS–NB; Ph.D., California (Berkeley)*
Asian-American literature

Brad Evans, *Assistant Professor of English, FAS–NB; Ph.D., Chicago*
Nineteenth- and 20th-century literature; cultural studies

Kate Flint, *Professor of English, FAS–NB; Ph.D., Oxford*
Nineteenth-century British literature

Sandy Flitterman-Lewis, *Associate Professor of English, FAS–NB; Ph.D., California (Berkeley)*
Cinema studies; feminist critical analysis

William H. Galperin, *Professor of English, FAS–NB; Ph.D., Brown*
Romantic literature; literary theory; media studies

Martin Gliserman, *Associate Professor of English, FAS–NB; Ph.D., Indiana*
English and American literature; psychoanalytic theory

Marcia Ian, *Associate Professor of English, FAS–NB; Ph.D., Virginia*
Modern British and American literatures; critical theory; the novel

Colin Jager, *Assistant Professor of English, FAS–NB; Ph.D., Michigan*
English romantic literature

Myra Jehlen, *Board of Governors Professor of Literature and Culture, FAS–NB; Ph.D., California (Berkeley)*
American literature; feminist criticism; cultural history

Samira Kawash, *Associate Professor of English, FAS–NB; Ph.D., Duke*
Nineteenth- and 20th-century minority and African-American literature; literary and cultural theory; race and ethnicity

Stacey Klein, *Assistant Professor of English, FAS–NB; Ph.D., Ohio State*
Old English and medieval studies; gender and sexuality

Richard Koszarski, *Associate Professor of English, FAS–NB; Ph.D., New York*
Cinema studies

Jonathan Brody Kramnick, *Associate Professor of English, FAS–NB; Ph.D., Johns Hopkins*
Seventeenth- and 18th-century literature and culture; critical theory

Daphne Lamothe, *Assistant Professor of English, FAS–NB; Ph.D., California (Berkeley)*
African-American fiction; black Atlantic culture and theories of migration; ethnography; folk culture

Ronald Levao, *Associate Professor of English, FAS–NB; Ph.D., California (Berkeley)*
English Renaissance literature and intellectual history

George Levine, *Kenneth Burke Professor of English, FAS–NB/CCACC; Ph.D., Minnesota*
Victorian literature; literature and science

Marc K. Manganaro, *Professor of English, FAS–NB; Ph.D., North Carolina (Chapel Hill)*
Modern literature/literary theory and anthropology; folklore and myth

John A. McClure, *Professor of English, FAS–NB; Ph.D., Stanford*
Contemporary American fiction; colonial and postcolonial discourse

Paula McDowell, *Associate Professor of English, FAS–NB; Ph.D., Stanford*
Eighteenth-century literature

Meredith L. McGill, *Associate Professor of English, FAS–NB; Ph.D., Johns Hopkins*
Nineteenth-century American literature, the history of the book, American poetry

Michael McKeon, *Board of Governors Professor of English, FAS–NB; Ph.D., Columbia*
Seventeenth- and 18th-century literature

Jacqueline T. Miller, *Associate Professor of English, FAS–NB; Ph.D., Johns Hopkins*
Renaissance literature

Richard Miller, *Associate Professor of English, FAS–NB; Ph.D., Pittsburgh*
Composition; pedagogy; cultural studies

Alicia Ostriker, *Professor of English, FAS–NB; Ph.D., Wisconsin*
Romantic, modern, and contemporary poetry; women's studies

Barry V. Qualls, *Professor of English, FAS–NB; Ph.D., Northwestern*
Victorian literature

Larry Scanlon, *Associate Professor of English, FAS–NB; Ph.D., Johns Hopkins*
Medieval studies; cultural studies; literary theory

Shuang Shen, *Assistant Professor of English, FAS–NB; Ph.D., CUNY*
Asian-American literature

Mary Sheridan-Rabideau, *Assistant Professor of English, FAS–NB; Ph.D., Illinois*
Composition, feminist studies; cultural studies

Jonah Siegel, *Associate Professor of English, FAS–NB; Ph.D., Columbia*
Nineteenth-century literature and culture; literature and the fine arts; modernism

Carol H. Smith, *Professor of English, FAS–NB; Ph.D., Michigan*
Modern literature; women's studies

Kurt Spellmeyer, *Associate Professor of English, FAS–NB; Ph.D., Washington*
Composition and rhetoric; 17th-century literature

William Vesterman, *Associate Professor of English, FAS–NB; Ph.D., Rutgers*
Eighteenth-century and American literature

Cheryl Wall, *Professor of English, FAS–NB; Ph.D., Harvard*
American and African-American literature; women's studies

William Walling, *Professor of English, FAS–NB; Ph.D., New York*
English romantics

Michael D. Warner, *Professor of English, FAS–NB; Ph.D., Johns Hopkins*
Colonial and 19th-century American literature; queer theory; social theory

Andrew Welsh, *Associate Professor of English, FAS–NB; Ph.D., Pittsburgh*
Old English and medieval studies; poetry

Carolyn S. Williams, *Associate Professor of English, FAS–NB; Ph.D., Virginia*
Victorian literature; women's studies; cultural studies

Programs

The Ph.D. program is open to students with outstanding academic records and other evidence of critical and scholarly talents. It does not admit students whose goal is an M.A., but only those intending to pursue a Ph.D. However, the program will award an M.A. on request to students who have either passed their orals or completed requirements noted in the program policy handbook (the *Redbook*). Applications for September admission to the New Brunswick program must be completed by January 2.

The Ph.D. requires 42 credits of course work, or at least 14 courses plus 6 credits of supervised reading and study carried out in preparation for the qualifying examination. The normal full-time course load is three courses per term. All students are required to take two 1.5-credit courses: 16:350:517 Critical Reading in their first term, and 16:350:518 Introduction to Advanced Research in their second term. Together, these two 1.5-credit courses equal one of the required 14 courses of course work. Each 1.5-credit course will be taken in addition to a student's normal three course per term schedule. Students are also required to complete a minimum of 24 research credits. Please refer to the program policy handbook (the *Redbook*) for details.

Graduate courses in the 500 series make knowledge available to sophisticated students who may not have encountered this material in their prior college studies. The 600-level concentration seminars allow more advanced and concentrated work in specialized areas.

Before students may take their orals, they must demonstrate proficiency in one foreign language. This requirement can be fulfilled in several ways and applicants should consult the program policy handbook (the *Redbook*) for details.

The Ph.D. qualifying examination consists of two hours of oral questioning. Please consult the program policy handbook (the *Redbook*) for a description of the current organization of this examination.

While working toward a doctorate in the Graduate Program in Literatures in English, students have the option of pursuing a concentrated study of the theory and practice of writing instruction. Upon completion of this program's requirements, students will receive a certificate in the teaching of writing from the Graduate School–New Brunswick. The certificate program consists of 9 credits, with 3 of them coming from a graduate seminar, 16:352:501 Teaching Writing: Theory and Practice. The remaining 6 are elective credits to be taken from a list of courses offered by the composition faculty in the Graduate Program in Literatures in English. As no one is permitted to pursue the certificate by itself, anyone seeking the certificate must be accepted into the Graduate Program in Literatures in English. Students who want to pursue a certificate must be accepted first into the Graduate Program in Literatures in English. The Graduate Program in Literatures in English does not admit students for the graduate certificate alone.

All applicants are urged to contact the Graduate Program in Literatures in English for more information, including details about financial assistance. Further details about the program itself are given in the program policy handbook (the *Redbook*). In addition, students may write to the Graduate Program in Literatures in English, Rutgers, The State University of New Jersey, 510 George Street, New Brunswick, NJ 08901-1167. The program can be reached by telephone at 732/932-7674, and via the web at *http://english.rutgers.edu/main.htm.*

Graduate Courses (350)

16:350:501,502. Independent Study (3,3)
An independent study course in directed readings available only by special arrangement.

16:350:503. Studies in Narrative Form (3)
Types of narrative (the tale, legend, romance, epic) and their relation to the novel.

16:350:504. Studies in Dramatic Form (3)
Types of drama (comedy, tragedy, history, melodrama) and their relation to theater and performance.

16:350:505. Studies in Poetic Form (3)
Types of poetry (epic, dramatic, lyric) and particular poetic forms, conventions, and movements (sonnet, elegy, epigram, ballad, ode, free verse, imagist poetry, symbolist poetry) and their relation to various expressive conventions and techniques.

16:350:506. Literary Theory I: Beginning through the 18th Century (3)
Conventions and recurrent problems in critical discourse from Aristotle to Kant.

16:350:507. Literary Theory II: Nineteenth Century to the Present (3)
Establishment of the modern aesthetic understanding of literary discourse and efforts to modify or revise it.

16:350:508. Critical Methodologies: Primary Texts (3)
Examination of selected major theoretical texts that inform the practice of literary study.

16:350:509. Studies In Critical Methodologies (3)
History and practices of literary theory: Marxist, psycho-analytic, feminist approaches; structuralism, poststructuralism; cultural studies.

16:350:510. Theories of Gender and Sexuality (3)
Key texts, authors, issues, and problems in the history of gender and sexuality in the second half of the 20th century.

16:350:511. Studies in Colonial/Postcolonial Theory (3)
Theoretical writing, emerging during and after the transition from colonialism to national independence in Asia, Africa, and other areas of the world. Authors who have explored and debated the meaning and the limits of decolonization.

16:350:512. Cultural Studies (3)
Examines fundamental assumptions in the understanding of culture; attempts to give students the interpretive skills to engage critically with contemporary cultural contexts.

16:350:513. New Technologies: Texts, Subjects, Communities (3)
Introduction to theoretical perspectives on electronic culture and communication in relation to literary studies; examination of the implications of digital and information technologies for text, representation, subjectivity, embodiment, and community.

16:350:514. Literature and Politics (3)
Study of literary texts directly connected to political debate and of critical theories, especially Marxist criticism, generated by the intersection of politics and literary form.

16:350:515. Myth, Religion, and Literature (3)
Recurrences and transformation of mythic motifs in selected texts.

16:350:517. Critical Reading (1.5)
Various ways of reading texts, with attention to the history and theory of modes of reading from "new criticism" to poststructuralism.

16:350:518. Introduction to Advanced Research (1.5)
Methods and resources for research in literary criticism, textual criticism, and related historical and cultural topics.

16:350:519. History and Criticism of Film (3)
Development of film as an art form: film technique, theoretical and practical criticism.

16:350:520. Studies in Film (3)
Selected topics in film studies, such as women and film, literature and film, or film and society.

16:350:528,529. Studies in Old English (3,3)
First term: introduction to Old English grammar, with readings from selected texts. *Second term: Beowulf.*

16:350:530. Chaucer (3)
Major works of Geoffrey Chaucer, including *Troilus and Criseyde* and *The Canterbury Tales,* in relation to late medieval culture.

16:350:531. Studies in Medieval Literature (3)
Relations between English medieval literature and other litera-tures, such as classical and continental; literary relations with other disciplines, such as folklore, history, and anthropology.

16:350:532. Gender and Sexuality in Medieval Literature and Culture (3)
Consideration of sexual difference, virginity, medical practices, and social structures for gender regulation.

16:350:533. Medieval Drama (3)
Medieval drama from the 11th through the early 16th century: investigation of surviving scripts and material production, with attention to recent developments in gender studies, performance theory, and cultural studies.

16:350:536,537. Studies in Renaissance Literature (3,3)
Major writers of the 16th and early 17th centuries approached through modern critical ideas of form, genre, convention, theme, and style.

16:350:538. Forms of Renaissance Literature (3)
Studies in literary forms that gave expression to major themes in the sixteenth and early seventeenth centuries: heroic, pastoral, satirical, tragic, comic.

16:350:539. Renaissance Drama 3)
Readings from selected Tudor and Stuart playwrights.

16:350:540. Shakespeare (3)
General study of Shakespeare's works.

16:350:541. Milton (3)
Milton's poetry and selected prose.

16:350:542. Studies in the 17th Century (3)
Survey of 17th-century literature, including Jacobean, Caroline, Civil War, interregnum, and Restoration poetry, prose, and drama. Study of influential literary historical and theoretical narratives written about this century.

16:350:546. British Poetry and Nonfiction Prose of the Early Enlightenment (3)
Readings from Dryden to Pope.

16:350:547. BRITISH POETRY AND NONFICTION PROSE OF THE LATER ENLIGHTENMENT (3)
Readings from Johnson to Preromanticism.

16:350:548. RESTORATION AND 18TH-CENTURY DRAMA (3)
Restoration comedy, tragedy, heroic play, and dramatic criticism; 18th-century survivals and transformations.

16:350:549. THE EARLY ENGLISH NOVEL (3)
Emergence of prose fiction as a literary genre and its evolution into a complex and self-conscious form. Texts by Defoe, Richardson, Fielding, Sterne, Smollett, Scott, Austen.

16:350:550. STUDIES IN 18TH-CENTURY LITERATURE AND CULTURE (3)
The main modes, actions, and styles in 18th-century writing.

16:350:551. GENDER AND SEXUALITY IN 18TH-CENTURY LITERATURE AND CULTURE (3)
Readings in Restoration and 18th-century literature that illuminate questions of erotics and gender. Texts by Rochester, Behn, Manley, Haywood, Cleland, Wollstonecraft, and others.

16:350:553. STUDIES IN EARLY AMERICAN LITERATURE AND CULTURE (3)
A limited number of major American writers of common historical background and intellectual temper.

16:350:554. COLONIAL ANGLO-AMERICA (3)
Selected colonial and early 19th-century writers, with emphasis on modern scholarship, criticism, and intellectual history.

16:350:555. EARLY NATIONAL U.S. LITERATURE (3)
Writings from the Revolution to the 1820s and 1830s. Texts by Paine, Jefferson, Equiano, Wheatley, Rowson, Foster, Brown, Irving, Cooper, and others.

16:350:556. AMERICAN ANTEBELLUM WRITING (3)
Study of what is often called the American Renaissance, from the 1830s to the Civil War. Texts by Emerson, Thoreau, Hawthorne, Melville, Poe, Whitman, Stowe, and others.

16:350:559. AMERICAN DRAMA AND CULTURE (3)
Historical and contemporary efforts to understand American drama's position, role, and status within local, national, and international cultures.

16:350:560. AMERICAN CULTURAL STUDIES (3)
Survey of American cultural studies and exercises in its practice. Texts by Berlant, Brenkman, and others; a range of literary and cultural materials.

16:350:561. THE ROMANTIC CENTURY (1750–1850) (3)
Aspects of British writing leading up to, including, and succeeding the Romantic period in England (1785–1835). Study of the evolution of key literary genres in relation to historical developments in culture and society.

16:350:562. STUDIES IN ROMANTICISM (3)
The revolt against tradition and the redefinition of poetry and the poet.

16:350:563. FICTION OF THE ROMANTIC PERIOD (3)
The rise of the novel in the context of the Romantic movement. Interrogation of assumptions governing Romanticism and realism in English prose fiction, 1770–1830.

16:350:566. STUDIES IN 19TH-CENTURY LITERATURE AND CULTURE (3)
Study of the major preoccupations and styles of the period in nonfiction, poetry, and the novel. Emphasis on the effects of historical and social developments.

16:350:567. NINETEENTH-CENTURY THEATER AND CULTURE (3)
Consideration of the genres of 19th-century theater, as well as popular forms of performance and spectatorship outside the theater.

16:350:568. THE VICTORIAN FIN DE SIÈCLE (3)
Study of aesthetic and philosophical developments in Pater, Meredith, Hardy, Conrad, Wells, Beerbohm, and others.

16:350:569. VICTORIAN CULTURAL STUDIES (3)
Material and methods of Victorian cultural studies. Consideration of effects of the French Revolution; technological innovation; newly consolidating economic systems. Texts by Burke, Schiller, Carlyle, Mill, Arnold, and others.

16:350:570. GENDER AND SEXUALITY IN VICTORIAN LITERATURE AND CULTURE (3)
Study of the relationships between gender representations in political and literary writing and female experience in Victorian England.

16:350:571. VICTORIAN POETRY (3)
Introduction to English poetry from late 1820s to early 1900s. Works of Tennyson, Robert Browning, Elizabeth Barrett Browning, Hopkins, Yeats, Landon, Hemans, Field, and others.

16:350:572. VICTORIAN FICTION (3)
Readings in selected novels and novelists from about 1800 to 1900, drawing especially on the works of Scott, Dickens, Thackeray, the Brontës, George Eliot, and James.

16:350:573. TRANSATLANTIC 19TH-CENTURY STUDIES (3)
The transatlantic formation and contestation of literary forms and cultural politics.

16:350:574. NINETEENTH-CENTURY DISCOURSES OF RACE, NATION, AND EMPIRE (3)
Discourse theory and its application in the politically charged domains of race, nation, and empire. Theoretical work of Foucault, Bakhtin, Said, Anderson, and others.

16:350:576. STUDIES IN 19TH-CENTURY AMERICAN LITERATURE AND CULTURE (3)
A limited number of major American writers of common historical background and intellectual temper.

16:350:577. NINETEENTH-CENTURY AMERICAN POETRY (3)
Examination of the exchange between public and private verse in 19th-century American poetic culture. Texts by Bryant, Holmes, Longfellow, Jackson, Whitman, Dickinson, Dunbar, and others.

16:350:578. LATER 19TH-CENTURY AMERICAN FICTION (3)
Writings of the last half of the 19th century, with some extension into the 20th century.

16:350:579. STUDIES IN 19TH-CENTURY AFRICAN-AMERICAN LITERATURE AND CULTURE (3)
Literary forms that give expression to major themes in 19th-century African-American literature: authenticity, authority, literacy, freedom, and nationhood.

16:350:584. EARLY MODERNISMS AND THE HISTORICAL AVANT-GARDE (3)
Modernism and the historical avant-garde as antithetical yet complementary moments in late 19th- and early 20h-century Europe and the United States.

16:350:585. DRAMATIC MODERNISMS (3)
Drama and performance as transatlantic modernist forms. Philosophical, social, and political questions in Ibsen, Hurston, Brecht, Stein, and others.

16:350:586. EARLY 20TH-CENTURY POETRY (3)
Hardy, Yeats, Pound, Eliot, Stevens, and others.

16:350:587. EARLY 20TH-CENTURY FICTION (3)
Hardy, James, Joyce, Woolf, and others.

**16:350:588. TWENTIETH-CENTURY AFRICAN-AMERICAN LITERATURE
  AND CULTURE (3)**
Works of various black American writers, read in conjunction with
other examples of American literature of the 20th century.

**16:350:589. STUDIES IN AFRICAN-AMERICAN LITERATURE
  AND CULTURE (3)**
African-American literature in relation to the multiple literary and
historical contexts from which it is produced. Course may high-
light specific topics (writing by black women) or genres (the essay).

16:350:590. LATER 20TH-CENTURY FICTION (3)
Prose fiction written in English since World War II in relation
to questions raised by critical theory, cultural studies, and
literary criticism.

16:350:591. LATER 20TH-CENTURY POETRY (3)
Study of continuity and change in the poetry of the mid-20th
century. Focus on several pivotal figures in their social and
political contexts.

16:350:592. LATER 20TH-CENTURY DRAMA AND PERFORMANCE (3)
Later 20th-century drama and performance, both in relation
to high modernist and postmodern cultures.

**16:350:593. STUDIES IN ETHNIC AMERICAN LITERATURES AND
  CULTURES (3)**
Central texts of English and American literature from the perspec-
tive of minorities and non-Western people.

16:350:594. TWENTIETH-CENTURY LITERATURE AND CULTURE (3)
Twentieth-century texts and authors in relation to cultural develop-
ments: aesthetic pluralization, war, secularization, diaspora, capi-
talism, and technology.

16:350:595. POSTCOLONIAL LITERATURES AND CULTURES (3)
Introduction to Anglophone (and some non-Anglophone) literature
and to theoretical debates concerned with colonialism and decolo-
nization in Africa, South Asia, and the Caribbean.

16:350:596. STUDIES IN MODERNISM (3)
Literary modernisms, 1880–1945, including genres, techniques,
philosophical questions, historical and cultural contexts, and social
and political issues.

16:350:597. STUDIES IN POSTMODERNISM (3)
Literatures and performances of postmodernism, late 1950s–2000,
including genres, techniques, and theories, as well as cultural and
political debates and movements.

16:350:598. CONTEMPORARY LITERATURE AND CULTURE (3)
Diverse works in fiction, poetry, drama, and film, created over
the past 15 to 20 years, that contribute to our sense of the contem-
porary moment.

**16:350:601,602. READINGS IN BRITISH AND AMERICAN
  LITERATURE (3,3)**
Intensive reading in any period of English and American literature
in preparation for the Ph.D. qualifying examination.

16:350:603. SEMINAR: GENRE THEORY (3)
Investigation into the nature and utility of the category of genre in
literary theory and practice.

16:350:604. SEMINAR: THEORIES OF NARRATIVE (3)
Narrative forms (biography, case history, ethnography) in relation
to the novel as genre and the interdisciplinary theory of narrative.

**16:350:605. SEMINAR: FEMINIST THEORIES AND
  CONTROVERSIES (3)**
Intensive investigation of theoretical arguments in second-
wave feminism concerning subjectivity, the body, agency, experi-
ence, community, and the challenges of postmodern and post-
colonial theory.

16:350:606. SEMINAR: TOPICS IN CULTURAL STUDIES (3)
Investigation of texts and materials using the methods of
cultural studies to illuminate a question or problem of contempo-
rary interest.

16:350:607. SEMINAR: TOPICS IN CRITICISM AND THEORY (3)
Selected texts in literary and cultural criticism; organized around
a key theoretical issue.

**16:350:608. SEMINAR: TOPICS IN COLONIAL/POSTCOLONIAL
  THEORY (3)**
Theoretical approaches to literatures and cultures produced within
or in response to the experience of colonization.

16:350:611. SEMINAR: CHAUCER (3)
Chaucer's works and issues for research: history of criticism,
theoretical frameworks, relations between Chaucer and his late
medieval milieu.

16:350:612. SEMINAR: MEDIEVAL LITERATURE (3)
Works of writers other than Chaucer; topics such as advanced
Old English language and literature, the Arthurian tradition,
Middle English dialects, women mystics, lyric poetry, medieval
literary theory.

16:350:613. SEMINAR: MEDIEVAL ROMANCE (3)
English and continental works, such as *Sir Gawain and the Green
Knight,* Malory's *Le Morte d'Arthur,* and the *Romance of the Rose* con-
sidered in generic terms as well as from other perspectives
such as historicist, feminist, and poststructuralist.

16:350:616. SEMINAR: SPENSER AND HIS CONTEMPORARIES (3)
Study of the poetry and related criticism.

16:350:617. SEMINAR: RENAISSANCE DRAMA (3)
Aspects of form in Elizabethan drama, with some attention to
Shakespeare. Staging, dramatic structure, conventions of character,
the interplay of verbal and nonverbal symbolism.

16:350:618. SEMINAR: TOPICS IN SHAKESPEARE (3)
Selected poems and plays; readings in related materials.

**16:350:619. SEMINAR: GENDER AND SEXUALITY IN RENAISSANCE
  LITERATURE (3)**
Exploration of representations of gender and sexuality, construc-
tions of masculinity and femininity, and conditions of writing for
women in the Renaissance.

**16:350:620,621. SEMINAR: TOPICS IN RENAISSANCE LITERATURE AND
  CULTURE (3,3)**
Topics of significant contemporary interest in the study of
Renaissance literature and culture.

**16:350:622. SEMINAR: TOPICS IN 17TH-CENTURY LITERATURE AND
  CULTURE (3)**
Topics of significant contemporary interest in the study of 17th-
century literature and culture.

**16:350:624. SEMINAR: EIGHTEENTH-CENTURY NONFICTION
  PROSE (3)**
Study of motives, conventions, styles, and cultural contexts with
emphasis on politics and rhetoric. Texts by Swift, Pope, Johnson,
and their contemporaries.

16:350:626. SEMINAR: EIGHTEENTH-CENTURY NOVEL (3)
Studies in Defoe, Fielding, Richardson, Sterne, Austen, and
their contemporaries.

16:350:627. Seminar: Eighteenth-Century Poetry (3)
Studies in Dryden, Pope, Gray, and their contemporaries.

16:350:628. Seminar: Eighteenth-Century Literary Criticism and Theory (3)
Major critical writings of Dryden, Addison, Johnson, and Reynolds; classical and continental backgrounds; the emergence of post-Augustan theories of imagination.

16:350:629. Seminar: Topics in 18th-Century Literature and Culture (3)
Topics of significant contemporary interest in the study of 18th-century literature and culture.

16:350:632,633. Seminar: Topics in Romantic Literature and Culture (3,3)
Critical study of two or more romantic poets in the context of the British and continental romantic movement.

16:350:634,635. Seminar: English Romantic Poets (3,3)
Critical study of the major works. Consideration of the relationship of Wordsworth and Coleridge and of their differing critical concepts.

16:350:636. Seminar: Jane Austen in Context (3)
Novels of Jane Austen considered in the contexts of 18th-century literature and social history, and of Victorian and modern criticism of fiction.

16:350:639. Seminar: Victorian Prose (3)
Study of one or more 19th-century prose writers (Carlyle, Mill, Newman, Darwin, Arnold, Ruskin, Pater) in historical and cultural contexts and in relation to current theoretical discussions of prose writing.

16:350:640. Seminar: Victorian Poetry (3)
Study of one or more Victorian poets (Tennyson, Barrett Browning, Browning, Arnold, Christina Rossetti, the Pre-Raphaelites, Hardy, Hopkins) in relation to genre, form, and cultural situation.

16:350:641. Seminar: Victorian Fiction (3)
Study of one or more major writers (Scott, Dickens, Thackeray, the Brontës, George Eliot, and Hardy) in conjunction with other genres in the period and current theoretical work on narrative.

16:350:642. Seminar: Topics in 19th-Century Literature and Culture (3)
Topics of significant contemporary interest in the study of 19th-century literature and culture.

16:350:645. Seminar: Colonial and Early 19th-Century American Literature (3)
Selected works and related scholarship.

16:350:646. Seminar: Nineteenth-Century American Fiction (3)
Consideration of the American romance; Gothic and Puritan influences in Irving, Cooper, Poe, Hawthorne, Stowe, Melville, Alcott, Twain, Howell, and James.

16:350:647. Seminar: Nineteenth-Century American Poetry (3)
Major texts of Whitman and Dickinson, Whitman's influence on modern poets of the "open form"; conflicts of self and culture.

16:350:648. Seminar: American Women Writers (3)
Cather, Glasgow, Wharton, Stein, and others in the context of the literature and social environs in which they worked.

16:350:649. Seminar: Major Authors in American Literature (3)
Significant texts and criticism; social and cultural contexts.

16:350:650. Seminar: Major Authors in Anglophone Literature (3)
Significant texts and criticism; social and cultural contexts.

16:350:653,654. Seminar: Topics in 20th-Century Studies (3,3)
Topics of significant contemporary interest in the study of 20th-century literature and culture.

16:350:655. Seminar: Topics in African-American Literature and Culture (3)
Topics of significant contemporary interest in the study of African-American literature and culture.

16:350:656. Seminar: Performance and Postmodern Theater (3)
Performance from DADAthrough the Situationists, Fluxus, and "performance art." Performance theory and practice in relation to dramatic texts and critical and social theory since the 1960s.

16:350:657. Seminar: Twentieth-Century Poetry (3)
Major works of selected 20th-century poets; critical and cultural contexts.

16:350:658. Seminar: Twentieth-Century Fiction (3)
Major works of selected 20th-century novelists; critical and cultural contexts.

16:350:659. Seminar: Literary Criticism and Social Critique (3)
Literary criticism as a method of social analysis; consideration of the overlap of politics and aesthetics.

16:350:660. Seminar: Topics in Colonial/Postcolonial Literatures and Cultures (3)
Literatures of Africa, Latin America, the Caribbean, and Southeast Asia that emerged in response to European colonization.

16:350:661. Seminar: Topics in Modernism/Postmodernism (3)
Topics that explore the divide/connection between modernism and postmodernism.

16:350:662. Seminar: Topics in Irish Literature and Culture (3)
Yeats, Synge, Joyce, and others in their cultural, social, and artistic contexts.

16:350:663,664. Seminar: Topics in Contemporary Literature and Culture (3,3)
Explores a specific problem, project, or practice in contemporary literature and culture.

16:350:701,702. Research in Literature (BA,BA)

Graduate Courses in Composition (352)

16:352:501. Teaching Writing: Theory and Practice (3)
Introduction to composition theory and pedagogical practice.

16:352:502. Introduction to Composition Studies (3)
Major theorists and central debates.

16:352:503. Introduction to Rhetorical Studies (3)
Major theorists and central debates.

16:352:504. Contemporary Issues in Composition Studies (3)
Assessment, placement, diversity, retention, teacher training, and other topics related to the theory and practice of writing instruction.

16:352:505. Feminism and Composition Studies (3)
Introduction to the major theorists and the central debates in feminism and composition studies.

16:352:601. SEMINAR: LITERACY AND PEDAGOGY (3)
Reading and writing in a variety of historical, cultural, and institutional contexts.

16:352:602. SEMINAR: WRITING PROGRAM ADMINISTRATION: THEORY AND PRACTICE (3)
Introduction to writing program administration, including labor and personnel issues, testing, and other common institutional practices.

16:352:603. SEMINAR: WRITING AND TECHNOLOGY (3)
Theory and practice of computer-assisted writing instruction, including email, discussion lists, web-page and web-site design, and the paperless classroom.

16:352:604. SEMINAR: TOPICS IN COMPOSITION STUDIES (3)
In-depth study for experienced teachers and administrators covering issues of assessment, placement, diversity, retention, teacher training, and other topics related to the theory and practice of writing instruction.

ENGLISH AS A SECOND LANGUAGE 356

Director of the English as a Second Language Program: **Dr. Kathleen Lynch-Cutchin**, 107 Tillett Hall, Livingston Campus (732/445-7422)

Members of the Full-Time Faculty

Kathleen Lynch-Cutchin, *Ph.D.*
Eva-Maria Morin, *M.A.*
Virginia Schirripa, *M.A.*
Paul Sprachman, *Ph.D.*
Michael Wherrity, *Ed.D.*

Program

The English as a Second Language program provides instruction in English as a Second Language (ESL) to graduate students who need to improve their English language proficiency. Placement in all courses is by proficiency test or by subsequent assessment. All courses carry institutional credit toward full-time status. These course credits, however, cannot be applied toward degree requirements.

Graduate Courses

16:356:531. ESL ACADEMIC WRITING I (E3)
Writing course emphasizing the composing and revising process and addressing selected grammatical problems through error analysis.

16:356:532. ESL ACADEMIC WRITING II (E3)
Advanced writing course culminating in a coherent and cohesive research paper.

16:356:541. ESL SPEECH CENTER (EBA)
Weekly listening/speaking tutorial focusing on improving listening, pronunciation, and speaking skills.

16:356:560. ESL INTERNATIONAL TA PHONOLOGY (E3)
Focuses on distinguishing essential sounds, developing appropriate stress and intonation patterns, and improving listening skills.

16:356:561. ESL INTERNATIONAL TA LANGUAGE SKILLS (E3)
Introduces international teaching assistants to teaching methodology, as well as the linguistic, discourse, and cultural components of effective communication; provides practice by teaching to peers.

ENTOMOLOGY 370

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor James H. Lashomb**, Blake Hall, 93 Lipman Drive, Cook Campus (732/932-9774)

Members of the Graduate Faculty

Lena B. Brattsten, *Professor of Entomology, CC; Ph.D., Illinois*
Insect biochemistry and toxicology; molecular aspects of insect-plant associations
Timothy M. Casey, *Professor of Ecology and Evolution, CC; Ph.D., California (Los Angeles)*
Physiological ecology; energetics and thermoregulation
Wayne J. Crans, *Professor of Entomology, CC; Ph.D., Rutgers*
Mosquito biology; medical and veterinary entomology; epidemiology of disease transmission
Randy Gaugler, *Professor of Entomology, CC; Ph.D., Wisconsin*
Invertebrate pathology; parasitology; biological control
Gerald M. Ghidiu, *Extension Entomologist, CC; Ph.D., Iowa State*
Vegetable insect pests
Ayodhya P. Gupta, *Professor Emeritus of Entomology, CC; Ph.D., Idaho*
Hemocytic and humoral immunity; morphology; physiology
George C. Hamilton, *Extension Specialist, CC; Ph.D., Rutgers*
Integrated pest management; biological control
Karl Kjer, *Assistant Professor of Entomology, CC; Ph.D., Minnesota*
Taxonomy, insect molecular systematics, molecular phylogenetics, aquatic insects
James H. Lashomb, *Extension Specialist, CC; Ph.D., Maryland*
Applied insect ecology; parasitic insect population dynamics; plant-herbivore interactions
Karl Maramorosch, *Robert L. Starkey Professor, CC; Ph.D., Columbia*
Insect pathology; virology; cell culture
Michael L. May, *Professor of Entomology, CC; Ph.D., Florida*
Physiological and behavioral ecology of insects
Sridhar Polavarapu, *Associate Extension Specialist, CC; Ph.D., New Brunswick (Canada)*
Blueberry and cranberry insect management
Peter W. Shearer, *Associate Extension Specialist, CC; Ph.D., Hawaii*
Integrated pest management for tree fruits, insect ecology, natural enemies, and alternative pest management options

Adjunct Members of the Graduate Faculty

Mark Robson, *Adjunct Professor of Entomology, CC; Ph.D., Rutgers*
Horticulture; public health
Marc E. Slaff, *Adjunct Assistant Professor of Entomology, CC; Ph.D., Rutgers*
Entomology; mosquito biology

Programs

The doctoral program normally requires 30 credits of course work and 42 credits of research. No foreign language is required. Ordinarily, two full research terms in residence are required, but this requirement may be waived by petition to the program faculty. The master's with thesis degree requires 24 credits of course work and 6 credits of research. Upon recommendation by the student's adviser and the advisory committee, the master's nonthesis degree may be awarded with the substitution of classes and an essay in the place of the thesis. The graduate program in entomology also publishes program guides for graduate studies, which explain requirements and are available upon request.

Graduate Courses

16:370:504. (S) MOSQUITO BIOLOGY (3)
Crans. Lec. 2 hrs., lab. 3 hrs. Prerequisite: Permission of instructor.
Biology, physiology, and behavior of mosquitoes on a worldwide basis; emphasis on current techniques used in field and laboratory investigations.

16:370:506. (S) INTEGRATED PEST MANAGEMENT (3)
Lashomb. Prerequisite: A background in entomology or other pest sciences and ecology. Recommended: Statistics. Students who lack background in these areas must obtain permission from the instructor.
Systems approach for measuring major ecological processes, such as development, mortality, and dispersal, presented as a means for evaluating pheromones, biocontrol, and cultural and pesticidal strategies in major crops.

16:370:507. (S) BIOLOGICAL CONTROL OF INSECT PESTS (3)
Gaugler. Prerequisite: General ecology.
Concepts and methods involved in the control of harmful insects and mites through the use of parasites, predators, and pathogens.

16:370:511. (F) PRINCIPLES OF SYSTEMATIC ENTOMOLOGY (3)
Kjer. Lec. 2 hrs., lab. 3 hrs.
Taxonomy, species concepts, methods of contemporary systematic research, and zoogeographic analysis.

16:370:515,516. (F) INSECT STRUCTURE AND FUNCTION (3,3)
Brattsten, May. Lec. 3 hrs., lab. 3 hrs. Prerequisite: 11:370:381 or equivalent. Required core course.
Physiology and functional morphology, including response systems, sensory systems, energy utilization, transport and secretion, and renewal systems.

16:370:517. (S) INSECT-PLANT BIOCHEMICAL INTERACTIONS (3)
Brattsten. See also 16:215:595. Prerequisites: Organic chemistry, biochemistry.
Biochemical aspects of interactions between herbivorous insects and their host plants, in particular those that involve adaptations to toxic plant allelochemicals. Biochemical aspects include metabolic and physiological defense mechanisms and mode of action and fate of phytochemicals.

16:370:519. (F) INSECT BEHAVIOR (3)
May. Prerequisite: Background in entomology and/or animal behavior.
Insect behavior from a functional standpoint: stimuli and responses; adaptative significance and evolutionary context; underlying physiological mechanisms.

16:370:522. (S) TOXICOLOGY OF PESTICIDES (3)
Brattsten. Lec. 2 hrs. Prerequisite: Advanced undergraduate biochemistry.
Mode of action, metabolism, and side effects of pesticides; their use in IPM, resistance mechanisms, and development; health, registration, and legal aspects.

16:370:524. (S) INSECT TAXONOMY (4)
Kjer. Lec. 2 hrs., lab. 6 hrs. Required core course.
Insect systematics, identification, natural history, and evolution. Emphasizes North American insects at the family level.

16:370:525. (S) INSECT ECOLOGY (3)
Lashomb. Prerequisite: General ecology.
Relationship between insect populations and elements of the physical and biotic environment. Emphasis on principles governing population size, quality, and spatial and temporal variation.

16:370:601,602. SPECIAL TOPICS IN ENTOMOLOGY (BA,BA)
Each term, faculty members arrange a series of topics in specialized fields of entomology.

16:370:603,604. SEMINAR IN ENTOMOLOGY (1,1)
Required core course (2 terms for M.S.; 3 terms for Ph.D.).
Discussion and critique of presentations by guest speakers.

16:370:605. INSECT COLLECTION (1)
Kjer. Prerequisite: 16:370:524.
Students make a properly curated, labeled, and identified insect collection.

16:370:701,702. RESEARCH IN ENTOMOLOGY (BA,BA)

ENVIRONMENTAL CHANGE, HUMAN DIMENSIONS OF 378

Program Offered: Certificate Program in the Human Dimensions of Environmental Change
Director of the Certificate Program in Human Dimensions of Environmental Change: Bonnie McCay, Human Ecology, Cook Office Building, Cook Campus (732/932-9153, ext. 314)

Participating Faculty

The following members and associate members of the graduate faculty, identified more fully under their respective programs, are among those who participate in the certificate program in human dimensions of environmental change.

C. Andrews, *Urban Planning and Policy Development*
J. Burger, *Ecology and Evolution*
C. Chess, *Human Ecology*
L. Clarke, *Sociology*
D. Ehrenfeld, *Ecology and Evolution*
J. Ehrenfeld, *Ecology and Evolution/Environmental Sciences*
F. Fischer, *Political Science*
J. Friedman, *Sociology*
M. Gochfeld, *Ecology and Evolution*
W. Goldfarb, *Environmental Sciences*
M. Greenberg, *Geography/Public Health*
P. Guarnaccia, *Anthropology*
D. Guston, *Urban Planning and Policy Development*
W. Hallman, *Psychology*
J.M. Hartman, *Ecology and Evolution*
C. Hatfield, *Ecology and Evolution*
D. Hodgson, *Anthropology*
B. Holcomb, *Geography*
D.M. Hughes, *Anthropology*
R.W. Lake, *Geography*
R. Lathrop, *Ecology and Evolution/Geography/Environmental Sciences*
B. McCay, *Anthropology/Ecology and Evolution*
J. Miller, *Oceanography*
J.K. Mitchell, *Geography*
G.E.B. Morren, Jr., *Anthropology/Ecology and Evolution*
G. Nieswand, *Ecology and Evolution/Environmental Sciences/Geography*
K. Nordstrom, *Geography*
K. O'Neill, *Sociology*
P. Parks, *Agricultural Economics*
P. Pauly, *History*
S. Pickett, *Ecology and Evolution*
F. Popper, *Geography/Urban Planning and Policy Development*
C. Pray, *Agricultural Economics*
D. Robinson, *Geography/Environmental Sciences*
T. Rudel, *Geography/Sociology*
S. Schrepfer, *History*
R. Schroeder, *Geography*
L. Small, *Agricultural Economics*
D. Tulloch, *Geography*
A.P. Vayda, *Anthropology/Ecology and Evolution/Geography*
N. Weinstein, *Psychology*

Certificate Program

Students with an interest in human-induced environmental changes may pursue, in addition to their regular program of studies, a special concentration in the human dimensions of environmental change. Two competing foci define research on these human dimensions of environmental change. One strand of research, ecological and institutional in emphasis, addresses questions of changes in natural resources, land cover, and industrial metabolism. A second strand of research, more perceptual and behavioral in emphasis, focuses on risks, hazards, and disasters. In both fields, research accomplishment requires competence in the methods of several different disciplines. Students who fulfill the following requirements will receive a Certificate in the Human Dimensions of Environmental Change, signifying special achievement in the field. To receive the certificate, students must complete, in addition to the requirements in their major disciplines, one course in one of the other participating programs that focuses on the human dimensions of environmental change. Students also must complete a two-term sequence of courses in the human dimensions of environmental change.

Graduate Courses

16:378:501. SEMINAR ON THE HUMAN DIMENSIONS OF ENVIRONMENTAL CHANGE (3)
Multidisciplinary survey of the human dimensions of environmental problems and the full range of disciplinary approaches used to study these problems.

16:378:502. Topics Seminar: The Human Dimensions of Environmental Change (3)
Focus on a particular human dimension of environmental problems, such as commons problems/institutions, or on a particular environmental problem.

ENVIRONMENTAL SCIENCES 375

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Barbara Turpin, Environmental Science Building, Cook Campus (732/932-9540)**

Members of the Graduate Faculty

Alan Appleby, *Professor Emeritus of Radiation Science, CC; Ph.D., Durham*
Radiation chemistry; radiation interactions at the molecular level
Tamar Barkay, *Assistant Professor of Biochemistry and Microbiology, CC; Ph.D., Maryland*
Microbial transformation of metals
Anthony Broccoli, *Associate Professor of Environmental Science, CC; Ph.D., Rutgers*
Climate modeling, climate change
Brian T. Buckley, *Administrative Director of Laboratories, EOSHI; Ph.D., North Carolina State*
Analytical chemistry of environmental science
Joanna Burger, *Professor of Biology, FAS–NB, and of Ecology, Evolution, and Natural Resources, CC; Ph.D., Minnesota*
Behavioral ecology, ecotoxicology, ecological risk
Marcos Cheney, *Assistant Professor of Environmental Science, CC; Ph.D., California (Davis)*
Degradation of xenobiotic organic compounds on mineral surfaces and in soil environments
Keith R. Cooper, *Professor of Toxicology, CC; Ph.D., Rhode Island*
Xenobiotic metabolism and diseases of aquatic animals; animal models
Joan G. Ehrenfeld, *Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., CUNY*
Wetland ecology, soil ecology, ecosystems ecology, pollution impacts on ecosystems
Steven J. Eisenreich, *Professor of Environmental Science, CC; Ph.D., Wisconsin (Madison)*
Environmental organic chemistry of surface atmosphere and lakes/estuaries; fate and transport of organic compounds
Paul G. Falkowski, *Assistant Professor of Geological Sciences and Marine and Coastal Sciences, CC; Ph.D., British Columbia*
Evolution and ecology of marine phytoplankton and symbiotic algae
Donna E. Fennell, *Assistant Professor of Environmental Engineering, CC; Ph.D., Cornell*
Bioremediation; wastewater treatment; bioprocess modeling; anaerobic processes
Melvin S. Finstein, *Professor Emeritus of Environmental Science, CC; Ph.D., California (Berkeley)*
Pollution microbiology; waste treatment composting as a controlled system
Susan E. Ford, *Assistant Research Professor of Oyster Culture, CC; Ph.D., Duke*
Invertebrate pathology/parasitology; genetics and mechanisms of resistance to pathogens; physiological ecology of estuarine organisms
Jennifer Francis, *Assistant Research Professor of Marine and Coastal Sciences, CC; Ph.D., Washington*
Polar meteorology, remote sensing, air-sea-ice energy transfer
Michael A. Gallo, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Albany Medical College*
Food additives; phototoxins; dermatotoxicology
Emil J. Genetelli, *Professor Emeritus of Environmental Science, CC; Ph.D., Rutgers*
Biological wastewater treatment processes
Panos Georgopoulos, *Associate Professor of Environmental and Community Health, UMDNJ–RWJMS; Ph.D., California Institute of Technology*
Environmental modeling
Daniel Gimenez, *Assistant Professor of Environmental Science, CC; Ph.D., Minnesota*
Soil structure; water movement and solute transport through soils; soil quality
William Goldfarb, *Professor of Environmental Science, CC; Ph.D., Columbia*
Environmental water resources; hazardous substances law and policy
Fred Grassle, *Director, Institute of Marine and Coastal Sciences, CC; Ph.D., Duke*
Ecology of marine bottom-dwelling organisms
Max M. Haggblom, *Associate Professor, Biotechnology Center for Agriculture and the Environment, CC; Ph.D., Helsinki*
Environmental and applied microbiology; biodegradation and bioremediation
Robert P. Harnack, *Professor of Meteorology, CC; Ph.D., Maryland*
Synoptic and climatic aspects of meteorology
John A. Hogan, *Assistant Professor of Environmental Science, CC; Ph.D., Rutgers*
Biological waste treatment, life support systems, pollution prevention

Sidney A. Katz, *Professor of Chemistry, FAS–C; Ph.D., Pennsylvania*
Environmental, nutritional, and toxicological aspects of trace elements
Stanley E. Katz, *Research Professor of Microbiology, CC; Ph.D., Rutgers*
Antibiotic residues in tissues and soils
Kathleen I. Keating, *Professor of Environmental Science, CC; Ph.D., Yale*
Trace element nutrition, plankton community structure and defined media for zooplankton and phytoplankton culture
Lee Kerkhof, *Assistant Professor of Marine and Coastal Sciences, CC; Ph.D., California (San Diego)*
Marine microbiology and molecular biology; microbial population dynamics
Uta Krogmann, *Assistant Professor of Environmental Science, CC; Ph.D., Hamburg-Harburg*
Solid-waste management and engineering, biosolids, recycling, waste minimization, anaerobic digestion, composting
Jerome J. Kukor, *Assistant Professor of Environmental Science, CC; Ph.D., Michigan*
Biochemistry of microbial degradation of aromatic and aliphatic compounds
Paul J. Lioy, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Rutgers*
Human exposure to pollutants; air pollution; industrial hygiene; risk assessment
Gediminas Mainelis, *Assistant Professor of Environmental Science, CC; Ph.D., Cincinnati*
Biological and nonbiological aerosols, exposure monitoring and control
James R. Miller, *Professor of Marine and Coastal Sciences, CC; Ph.D., Maryland*
Meteorology; atmospheric modeling
George H. Nieswand, *Professor of Environmental Systems Engineering, CC; Ph.D., Rutgers*
Environmental systems analysis
Christopher C. Obropta, *Assistant Professor of Environmental Science, CC; Ph.D., Stevens*
Watershed management stormwater best management practices
Claire E. Reimers, *Professor of Marine and Coastal Sciences, CC; Ph.D., Oregon State*
Marine carbon cycle; sedimentary geochemistry
John R. Reinfelder, *Assistant Professor of Environmental Science, CC; Ph.D., SUNY (Stony Brook)*
Trace metal biogeochemistry of aquatic systems; phytoplankton ecology
Nathan M. Reiss, *Associate Professor Emeritus of Meteorology, CC; Ph.D., New York*
Air-pollution meteorology; physical meteorology
David A. Robinson, *Professor of Geography, FAS–NB; Ph.D., Columbia*
Climate and climate change
Alan Robock, *Professor of Meteorology, CC; Ph.D., Massachusetts Institute of Technology*
Climate change, climate modeling, soil moisture
Mark G. Robson, *Associate Professor and Director, Division of Environmental and Occupational Health, UMDNJ–SPH; Ph.D., Rutgers*
Public health risk assessment; exposure to pesticides
Stuart L. Shalat, *Associate Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Harvard*
Epidemiologic studies of environmental toxins effects on the fetus and the child
Robert M. Sherrell, *Associate Professor of Marine and Coastal Sciences, CC; Ph.D., Massachusetts Institute of Technology*
Marine geochemistry of trace metals and natural radionuclides
Georgiy L. Stenchikov, *Research Professor of Environmental Science, CC; Ph.D., Moscow Physical Technical Institute*
Climate modeling, cloud modeling, air pollution, computational fluid dynamics, radiative transport, numerical methods
Peter F. Strom, *Associate Professor of Environmental Science, CC; Ph.D., Rutgers*
Biological treatment; hazardous wastes
Gary L. Taghon, *Associate Professor of Marine and Coastal Sciences, CC; Ph.D., Washington*
Marine ecology
Robert L. Tate III, *Professor of Soils and Crops, CC; Ph.D., Wisconsin*
Soil microbiology
Paul E. Thomas, *Professor of Chemical Biology and Pharmacognosy, EMSP; Ph.D.,Ohio State*
Metabolism of drugs and environmental chemicals, cytochrome P-450
Lisa A. Totten, *Laboratory Researcher, Environmental Sciences, CC; Ph.D., Johns Hopkins*
Semivolatile organic contaminant fate and transport; reactivity and QSARs
Barbara J. Turpin, *Associate Professor of Environmental Science, CC; Ph.D., Oregon Graduate Institute*
Air pollution; the chemistry and physics of atmospheric aerosols
Christopher G. Uchrin, *Professor of Environmental Science, CC; Ph.D., Michigan*
Math modeling of contamination transport in surface and groundwater
Dana E. Veron, *Assistant Professor of Atmospheric Science, CC; Ph.D., California (San Diego)*
Modeling of clouds, radiation, and climate
Christopher P. Weaver, *Assistant Research Professor of Meteorology, CC; Ph.D., Scripps*
Climate change and feedbacks; land-atmosphere interactions; clouds and earth's radiation budget; numerical modeling

Judith S. Weis, *Professor of Zoology, FAS–N; Ph.D., New York*
Effects of environmental factors, including pollutants, on development and growth of estuarine organisms
Clifford P. Weisel, *Assistant Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Rhode Island*
Measurement of environmental constituents to assess human exposure
Lily Y.Young, *Professor of Environmental Science, CC; Ph.D., Harvard*
Anaerobic microbial metabolism of environmental contaminants; microbial ecology
Junfeng Zhang, *Assistant Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Rutgers/University of Medicine and Dentistry of New Jersey*
Air pollution, exposure assessment, atmospheric chemistry and greenhouse gases
Gerben J. Zylstra, *Professor of Biochemistry and Microbiology, BCAE; Ph.D., Michigan*
Genetics and physiology of microbial aromatic hydrocarbon degradation

Associate Members of the Graduate Faculty

John W. Baum, *Senior Scientist, Brookhaven National Laboratory; Ph.D., Michigan*
Radiological physics; bioeffects and risks of ionizing and nonionizing radiations
Edward A. Christman, *Director of Environmental Health and Safety, Columbia University; Ph.D., Rutgers*
Radiation safety; health physics
Nancy L. Fiedler, *Associate Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Bowling Green State*
Neurobehavioral and health effects in human exposure to hazardous substances
Elan J. Gandsman, *Director of Health and Safety, Yale University; Ph.D., Tel Aviv*
Medical imaging; health physics; radiation safety; occupational health
Francis J. Haughey, *Professor Emeritus of Radiation Science, CC; Ph.D., Rutgers*
Radiation, aerosol, and health physics; environmental radioactivity
Robert Hordon, *Associate Professor of Geography, FAS–NB; Ph.D., Columbia*
Surface and groundwater hydrology; water quality
Joseph V. Hunter, *Professor Emeritus of Environmental Science, CC; Ph.D., Rutgers*
Source, fate, and detection of water and soil pollutants
Howard Kipen, *Assistant Professor of Environmental and Community Medicine, UMDNJ–RWJMS; M.D., California (San Francisco)*
Occupational health
Richard Lathrop, *Associate Professor of Environmental Resources, CC; Ph.D., Wisconsin (Madison)*
Remote sensing and spatial modeling of terrestrial aquatic ecosystems
Theodore B. Shelton, *Specialist of Agriculture and Resource Management, CC; Ph.D., Rutgers*
Water resources planning and management
K. David Steidley, *Chief Physicist, St. Barnabas Medical Center; Ph.D., Rutgers*
Medical physics; biophysics; health physics; computers in medicine
Wesley R. Van Pelt, *President, Wesley R. Van Pelt Associates, Inc.; Ph.D., New York*
Health physics; industrial hygiene; radiation dosimetry; environmental radioactivity
Stephen M. Waldow, *Clinical Assistant Professor, UMDNJ, and Director, Division of Radiation Research, Cooper Hospital; Ph.D., SUNY (Buffalo)*
Radiation biology; radiation therapy; models of tumor treatment

Adjunct Members of the Graduate Faculty

Natalie Freeman, *Adjunct Assistant Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Rutgers*
Nonoccupational exposure of adults/children; questionnaire development
Norberto J. Palleroni, *Research Professor of Agricultural Molecular Biology, CC/BCAE; Ph.D., Buenos Aires*
Taxonomic and phylogenetic studies of environmentally important bacteria
Alan Stern, *Research Scientist, New Jersey Department of Environmental Protection and Energy; Ph.D., Columbia*
Population exposures to metals in the environment
Arthur C. Upton, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Michigan*
Biological effects and risks of ionizing radiation

Programs

The M.S. and Ph.D. degree programs offer concentrations in pollution prevention and control; fate and effects of pollutants; atmospheric science; exposure assessment (Ph.D. only); and environmental toxicology (Ph.D. only). The Ph.D. option in exposure assessment is offered jointly with the graduate program in public health and in conjunction with the Department of Environmental and Community Medicine at UMDNJ–RWJMS. Within these options, the following areas of specialization are offered: air pollution and resources; aquatic biology; aquatic chemistry; aquatic toxicology; assessment; chemistry and physics of aerosol and hydrosol systems; climate change; environmental chemistry; environmental microbiology; environmental prediction; surface and groundwater pollution modeling; human exposure; industrial hygiene; occupational health; pesticide residue chemistry; soil chemistry; soil microbiology; soil physics; solid and hazardous wastes; water and wastewater treatment; and water resources.

The backgrounds of successful applicants vary greatly. All are expected to have earned an undergraduate degree in a science or an engineering discipline with appropriate background in biology, chemistry, mathematics, and physics. Accepted applicants who lack any of the above requirements may be required to correct this deficiency.

The M.S. program offers two plans: (1) 24 credits of course work, 6 credits of research, and a comprehensive oral examination that includes defense of a thesis; or (2) 30 credits of course work, submission of an acceptable critical essay, and a comprehensive oral examination.

The Ph.D. degree requires a minimum of 72 credits beyond the bachelor's degree, with 36 of those credits taken in course work and 24 as research credits. The remaining 12 credits may be in either courses or research. In addition, candidates must complete successfully and defend a research dissertation.

The qualifying exam includes both written and oral parts. Following admission to candidacy, students must submit a formal research proposal to their dissertation committee. One year's residence, defined as full-time status for one academic year consisting of two consecutive terms, normally is required. There is no foreign language requirement.

Core Requirements

All graduate students must take at least one course in each of the following areas; Ph.D. students must fulfill this requirement before taking the qualifying exam.

Biological Systems

16:375:510   Environmental and Pollution Microbiology
16:375:519   Wetland Ecology
16:375:573   Topics in Soil Organic Matter

Environmental Chemistry

16:375:517   Applications of Aquatic Chemistry
16:375:523   Environmental Fate and Transport
16:375:540   Atmospheric Chemistry

Environmental Physics

16:375:509   Groundwater Pollution
16:375:532   Atmospheric Physics
16:375:555   Soil Physics

Management and Policy

16:375:530   Hazardous Waste Management
16:375:535   Environmental Law and Policy
ENOH-0656-001 Risk Assessment

Additionally, all M.S. students must take at least one credit seminar, and all Ph.D. students must take at least two 1-credit seminars.

Graduate Courses

16:375:501. (F) ENVIRONMENTAL SCIENCE ANALYSIS (3)
Physical, chemical, and biochemical processes utilized to treat municipal wastewaters. Process mechanisms, treatment efficiencies, and their relationship to wastewater quality; techniques utilized to obtain maximum efficiency.

16:375:502. (S) STREAM SANITATION (3)
Genetelli
Principles of biological stabilization of pollution materials in streams; factors influencing atmosphere reaeration; changes in biological populations in polluted waters.

16:375:503. (F) ANALYTICAL TECHNIQUES IN ENVIRONMENTAL CHEMISTRY (3)
Prerequisite: 11:375:405 or permission of instructor.
Theory and techniques of analytical procedures applicable to research in environmental science.

16:375:504. (S) WASTE TREATMENT II: WATER TREATMENT (3)
Chemical, physical, and biological factors affecting development of water supplies; water quality; municipal and industrial water treatment processes consisting of removal of particulate matter, softening, disinfection, corrosion control, iron and manganese removal, aeration, deaeration, and taste and odor removal.

16:375:505. (S) WASTE TREATMENT II: WATER TREATMENT LABORATORY (1)
Lab. 3 hrs. Corequisite: 16:375:504.
Experiments demonstrating water treatment processes.

16:375:506. (S) WASTE TREATMENT III: INDUSTRIAL WASTES (2)
Prerequisite: 16:375:501.
Industrial waters; industrial processes and sources of wastes; composition, characteristics, and effects; methods of treatment, disposal, and recovery.

16:375:507. (F) ENVIRONMENTAL CHEMISTRY (3)
Equilibria: acid-base, dissolution and precipitation, multiphase; oxidation-reduction in aquatic systems; elements of chemical thermodynamics.

16:375:509. (F) GROUNDWATER POLLUTION (3)
Uchrin. Prerequisites: 16:375:504 and 541, or permission of instructor.
Principles of groundwater hydrology and pollution. Development of mathematical formulations for describing pollutant movement in groundwater systems. Examination of control measures. Discussion of case studies.

16:375:510. (S) ENVIRONMENTAL AND POLLUTION MICROBIOLOGY (3)
Kukor, Young. Prerequisite: Introductory course in microbiology or permission of instructor.
Microorganisms in carbon, nitrogen, sulfur cycling, biogeochemical processes, and water and wastewater treatment systems; biodegradation strategies and pathways; and bioremediation of toxic contaminants in the environment.

16:375:512. (F) POLLUTION MICROBIOLOGY LABORATORY (2)
Lab. 6 hrs. Corequisite: 16:375:510.
Laboratory exercises paralleling 16:375:510.

16:375:516. (S) ULTIMATE DISPOSAL AND RESOURCE RECOVERY OF SLUDGES AND SOLID WASTE (3)
Description and application of advanced technology for treatment, resource recovery, and ultimate disposal of sludges and solid wastes from municipal, industrial, and agricultural sources; techniques of theory of operation, process design, application, and performance; environmental and socioeconomic implications.

16:375:517. APPLICATIONS OF AQUATIC CHEMISTRY (3)
Reinfelder
Thermodynamics and kinetics of the chemical and biological processes that control the composition of natural and engineered waters, including gas and solid dissolution, chemical complexation, oxidation-reduction, adsorption, photosynthesis, aerobic and anaerobic respiration, biomineralization, and bioaccumulation. The component-tableau approach used to solve equilibrium problems and the computer program MINEQL to study complex aquatic systems.

16:375:518. (S) PRINCIPLES OF ENVIRONMENTAL SCIENCE (3)
Principles and interaction associated with air environment, water environment, and environmental health, including air resources management, water resources management, and their impact on man. Related fundamentals of environmental chemistry, biology, and physics.

16:375:519. (F) WETLAND ECOLOGY (3)
Ehrenfeld. Prerequisites: 11:704:351 or equivalent, and permission of instructor.
Survey of the ecology, management, and utilization of wetlands. Topics include the hydrology, soils, biogeochemistry, flora, fauna, and ecosystem dynamics of the major types of wetlands. Wastewater application, wetland creation, wildlife management, wetland assessment and delineation, and conservation also discussed.

16:375:520. (S) TECHNIQUES FOR BIOMONITORING IN AQUATIC ECOSYSTEMS (3)
Prerequisite: 16:375:519 or permission of instructor.
Discussion of techniques used to monitor for the presence of trace contaminants in aquatic ecosystems and to assess the effects of contaminants on the structure and function of these ecosystems.

16:375:522. (S) ENVIRONMENTAL ORGANIC CHEMISTRY (3)
Eisenreich. Prerequisite: Graduate standing or permission of instructor.
Transport and transformations of anthropogenic organic chemicals in the environment; chemical-physical properties of organic chemicals, air-water and air-land exchange, atmospheric processes and deposition, sorption processes, bioaccumulation, chemical transformation, photochemical transformations, modeling concepts, case studies.

16:375:523. (F) ENVIRONMENTAL FATE AND TRANSPORT (3)
Eisenreich, Uchrin. Corequisites: 11:375:444 or 451 or equivalent; CALC1, CALC2.
Fate and transport of chemicals, chemical exposures in aquatic systems, and prediction of future conditions. Water quality problems introduced by addition of nutrients and oxygen-demanding material, metals, and toxic organic chemicals to water, soil, and air. Models to assess environmental mobility and predict scenarios. New paradigm of "environmental indicators" to assess environmental quality emphasized.

16:375:524. (F) SOURCE CONTROL OF ATMOSPHERIC POLLUTION (3)
Turpin. Prerequisite: Permission of instructor.
Principles, operation, performance, and application of methods and devices to control aerosol and gaseous emissions.

16:375:525. (F) PRINCIPLES OF SOLID-WASTE MANAGEMENT AND TREATMENT (3)
Prerequisite: Permission of instructor.
Solid-waste problems in the municipal, industrial, and agricultural areas. Interrelationships with other environmental problems; socioeconomic aspects; present state-of-the-art techniques. Quality and quantity variations, treatment and management systems; recycling, source control.

16:375:526. (S) LIMNOLOGY OF URBAN AND SUBURBAN WATERS (3)
Keating. Prerequisite: Permission of instructor.
Study of waters stressed by population, development, wastes; emphasis on biological characterization of urban and suburban waters.

16:375:529. (F) BIODEGRADATION AND BIOREMEDIATION (3)
Basic principles of biodegradation science and bioremediation technology; microbiological, chemical, environmental, engineering, and technological aspects; fate and persistence of contaminants in complex environmental matrices; and microbial transformation and destruction of pollutants.

16:375:530. (S) HAZARDOUS WASTE MANAGEMENT (3)
Strom. Prerequisite: 16:375:525 or permission of instructor.
Overview of hazardous waste management. Case histories; legislation and regulations; treatment, disposal, and cleanup technologies; sampling and analysis methodologies; persistence and fate in the environment; emergency response procedures.

16:375:531. (F) BIOLOGICAL WASTE TREATMENT (3)
Strom. Prerequisites: 16:375:501 and 510, or permission of instructor.
Advanced topics in biological waste treatment, particularly activated sludge, focusing on microbial ecosystems.

16:375:532. (F) ATMOSPHERIC PHYSICS (3)
Veron. Prerequisite: Permission of instructor.
The atmospheric physics of gravitation, clouds and aerosols, precipitation, energy and momentum transfer, solar and terrestrial radiation, optics, acoustics, and electricity that play a role in the atmosphere.

16:375:533. (F) WATER LAW (3)
Examination of the water law doctrines and institutions that affect water resources management. Topics include water rights, water resources development, instream uses, and water pollution control.

16:375:535. (F) ENVIRONMENTAL LAW AND POLICY (3)
Legal and political interactions and intermediate institutional structures between environmental law and policy, with a focus on pollution-control law.

16:375:537. (F) LARGE-SCALE WEATHER SYSTEMS (3)
Harnack. Prerequisites: 11:670:201, 202, 11:670:323, 324, or equivalent.
Applied dynamics of the atmosphere, including the theory and observations of cyclone development, vertical motion, jet streams, fronts, and synoptic-scale circulation systems.

16:375:538. (S) MESOSCALE WEATHER SYSTEMS (3)
Harnack. Prerequisites: 11:670:323, 324 or equivalent.
Description, dynamics, and prediction of moist convective weather systems, such as supercells, mesoscale convective complexes, squall lines, and other multicellular storms.

16:375:539. (F) INTRODUCTION TO RADIATIVE TRANSFER IN THE ATMOSPHERE AND OCEAN (3)
Veron. Prerequisite: Permission of instructor.
Theory and simple models of radiative transfer in the ocean and atmosphere. Current research utilizing these techniques, including modeling clouds, aerosols and climate, and environmental remote sensing.

16:375:540. (S) ATMOSPHERIC CHEMISTRY (3)
Zhang. Prerequisite: 11:375:421 or permission of instructor.
Air pollutants, trace gases, and aerosols discussed in terms of their observed distribution in time and space; sources and sinks in the atmosphere and its boundaries; budgets and cycles. Emphasis on tropospheric chemical reactions.

16:375:541. (S) ENVIRONMENTAL MODELS (3)
Uchrin
Development and applications of environmental models discussed in terms of their ability to simulate and predict the workings of environmental systems and to communicate information and trade-offs between economic and conservation goals.

16:375:542. (S) AEROSOL SCIENCES (3)
Lioy. Prerequisite: Calculus. Recommended: Differential equations.
Topics include the dynamics, kinometics, and size characteristics of aerosols; methods for analysis of distribution and morphology; chemistry and physics of the formation of aerosols.

16:375:543. (S) MICROMETEOROLOGY (3)
Prerequisite: 11:670:324 or equivalent.
Theory of energy fluxes near and on both sides of the earth's surface, including sensible and latent heat transfer in the atmospheric boundary layer and soil-heat transfer; temperature, wind, and humidity structure of the boundary layer and the temperature structure of soil; experimental methods and equipment in micrometeorology.

16:375:544. (S) MODELING OF CLIMATIC CHANGE (3)
Robock, Stenchikov. Prerequisites: At least one graduate course in meteorology, oceanography, or physical geography. Knowledge of a high-level programming language, such as FORTRAN or C.
Climate models, including energy-balance, radiative-convective, and general circulation models. Actual practice running climate models and analyzing output.

16:375:545. (F) PHYSICAL CLIMATOLOGY (3)
Robock. Prerequisite: Abasic course in meteorology or climatology.
The climate system, surface-energy balance, past climate variations, climate-feedback mechanisms, climate modeling, causes of climate change, detection and attribution of anthropogenic climate change.

16:375:546. (S) AIR POLLUTION METEOROLOGY (3)
Prerequisites: 11:670:323, 324, or equivalent.
Theory and applications of air pollution dispersion modeling. Meteorological effects on and by cooling towers. Effects of pollutants on meteorological parameters.

16:375:547. (F) ATMOSPHERIC BOUNDARY LAYER DYNAMICS (3)
Prerequisite: 11:670:324 or equivalent.
Basic governing equations in the atmospheric boundary layer and their application to turbulent flow, including turbulent kinetic energy, turbulence closure techniques, forcing, and stability.

16:375:548. (S) ATMOSPHERIC NUMERICAL MODELING (3)
Prerequisite: 16:375:547 or equivalent.
Basic governing equations in the atmosphere, simplification, and scaling; parameterization of turbulence, radiation, and clouds; numerical methods for the solution of the mathematical system; boundary and initial conditions; evaluations of atmospheric models.

16:375:549. (F) APPLIED CLIMATOLOGY (3)
Prerequisites: 11:670:323, 324 or equivalent, one term of statistics, or permission of instructor.
Critical use of statistics as applied to climatology; analysis of meteorological time series. Application of various statistical distributions to regional climate diagnostics. Dynamic air mass analysis.

16:375:550. (S) LARGE-SCALE CLIMATE DIAGNOSTICS (3)
Harnack. Prerequisite: 16:375:549.
Observed characteristics of the general circulation of the atmosphere and surface layer of the oceans; atmospheric energetics; empirical studies of large-scale, air-sea interactions, tropical-midlatitude interactions, and recent climatic fluctuations; empirical methods of short-range climate prediction.

16:375:551. (S) REMOTE SENSING OF THE OCEAN AND ATMOSPHERE (3)
Miller. Prerequisite: 11:670:323 or equivalent.
Theoretical basis of remote sensing. Methods, instruments, and their application to observations of ocean and atmosphere. Remote sensing of oceanic parameters such as temperature, salinity, currents, sea state, turbidity and pollutants, and atmospheric parameters such as temperature, water vapor, cloud cover, wind speeds, and pollutants.

16:375:552. (F) SOIL GENESIS AND MORPHOLOGY (3)
Soil-forming processes in various climatic regions as evidenced by chemical, physical, and mineralogical characteristics of the profile. System of classification and literature review.

16:375:554. (S) SOIL AND PLANT RELATIONSHIPS (3)
Prerequisite: 11:375:452.
Selected topics related to factors affecting the chemical environment of the plant.

16:375:555. (F) SOIL PHYSICS (3)
Gimenez. Lec. 3 hrs. Prerequisite: Permission of instructor.
Study of transport processes of energy and matter through soils. Relationships between the movement of water; the transport of heat, gas, and solute; and the physical properties of soils.

16:375:559. (S) SOIL MANAGEMENT AND CROP PRODUCTION (3)
Influence of land management systems and cultural practices on soil productivity and environmental quality.

16:375:561. (F) Soil Chemistry (3)
Lec. 2 hrs., lab. 3 hrs.
Structural chemistry, formation mechanisms, chemical properties, weathering, and surface reactions of major soil components: silicates, aluminum hydroxides, and iron oxides.

16:375:568. (S) Topics in Soil Chemistry (3)
Chemistry of phosphate, potassium, and carbonate in soils; soil acidity and amendments; oxidation-reduction; ion exchange equilibria; pollution of the soils environment.

16:375:573. (S) Topics in Soil Organic Matter (3)
Tate
Role of organic matter in soil, extraction and analysis of soil organic matter, biodegradation and synthesis of humic and fulvic acids; biological and ecological aspects.

16:375:584. (S) Topics in Radiation Biology (3)
Current literature of radiation biology.

16:375:589,590. Seminar in Radiation Science (1,1)
Topics of current interest.

16:375:598. (S) Special Topics in Radiological Health (3)
Prerequisite: 16:375:591.
Advanced topics of current interest, background radiation levels, radiation exposure standards, external and internal radiation exposure limits, medical radiation exposure and protection, space radiation problems, environmental radioactivity.

16:375:601. Experimental Problems in Radiological Health (2)
Prerequisite: Completion of all other courses in the radiological health or health physics program. Offered in Summer Session only.
Series of problems requiring literature search, field and laboratory exercises, and written reports. Typical problems: reactor radiation survey, X-ray installation survey, environmental sample analysis. Laboratory and fieldwork.

16:375:603,604. Independent Study in Meteorology (BA,BA)
Prerequisite: Permission of instructor.
The student conducts an independent comprehensive literature review and investigation of meteorological areas of interest other than the thesis topic. Regular reports of progress made in conference.

16:375:605,606. Special Topics in Meteorology (3,3)
Prerequisite: Permission of instructor.
Selected topics in meteorology. Current literature and recent advances.

16:375:612,613. Seminar in Environmental Science (0,0)

16:375:625,626. Advanced Special Problems (BA,BA)

16:375:635. Experimental Problems in Environmental Science (BA)

16:375:651,652. Seminar in Soil Science (1,1)

16:375:671,672. Seminar in Meteorology (1,1)
Prerequisites: 11:670:323, 324, or equivalent.
Review of recent advances in meteorology.

16:375:701,702. Research in Environmental Science (BA,BA)
Research in water pollution, water and wastewater treatment, air pollution, and aquatic microbiology.

FOOD AND BUSINESS ECONOMICS 395

Degree Program Offered: **Master of Science**
Director of Graduate Program: **Professor Carl E. Pray,**
   110 Cook Office Building, Cook Campus (732/932-9155, ext. 219)

Members of the Graduate Faculty

Robin G. Brumfield, *Professor of Agricultural Economics, CC; Ph.D., North Carolina State*
   Production economics of the horticultural industry
Donn A. Derr, *Associate Professor of Agricultural Economics, CC; Ph.D., Ohio State*
   Natural and community resource economics
Ramu Govindasamy, *Associate Professor of Agricultural Economics, CC; Ph.D., Iowa State*
   Agricultural marketing; operations research; consumer economics
Peter J. Parks, *Associate Professor of Agricultural Economics, CC; Ph.D., California (Berkeley)*
   Environmental and resource economics; econometrics
Carl E. Pray, *Professor of Agricultural Economics, CC; Ph.D., Pennsylvania*
   Agricultural development; international development science and technology policy
Leslie E. Small, *Professor of Agricultural Economics and Associate Dean of Academic Administration, CC; Ph.D., Cornell*
   Agricultural development and irrigation management in Asia
Edmund M. Tavernier, *Associate Professor of Agricultural Economics, CC; Ph.D., Minnesota*
   Agricultural policy; trade
Calum G. Turvey, *Professor of Agricultural Economics and Director of the Food Policy Institute, CC; Ph.D., Purdue*
   Finance; risk management; agricultural and food policy

Associate Members of the Graduate Faculty

Sanjib Bhuyan, *Associate Professor of Agricultural Economics, CC; Ph.D., Connecticut*
   Economics of food industry; food marketing; cooperatives
Paul D. Gottlieb, *Associate Professor of Agricultural Economics, CC; Ph.D., Princeton*
   Economic development; land use; state and local policy making
Ferdaus Hossain, *Assistant Professor of Agricultural Economics, CC; Ph.D., Iowa State*
   Agricultural finance; international trade; applied demand analysis
Eliza M. Mojduszka, *Assistant Professor of Agricultural Economics, CC; Ph.D., Massachusetts (Amherst)*
   Economics of food product quality and imperfect information; demand analysis; food marketing

Programs

The graduate program in agricultural economics attempts to help students apply economic theory and methods to significant problems facing society. It emphasizes food and business.

The program offers two options for obtaining a master of science degree. The first involves 24 credits of course work and 6 additional credits for successful completion of a research thesis. Under the second route, students take 30 credits of course work and submit an acceptable 3-credit research paper on the economics of the food industry, agriculture, biotechnology, and natural resources and the environment. A full-time student normally takes two years to complete the program. Teaching and research assistantships that include tuition remission are available for a limited number of full-time students. To the extent that space is available, full-time students are assigned office space in the Cook Office Building, which houses the Department of Agricultural Economics.

All students are required to take introductory econometrics in their first term (unless they have taken this course before entering the program). The remaining core-course requirements consist of three graduate courses: microeconomic theory, research methods, and applied econometrics. Students must pass a comprehensive examination after they complete the required core courses. In addition, at least two other courses in agricultural economics must be taken. Selected courses may be taken from other programs, including anthropology, computer science, economics, environmental sciences, geography, political science, psychology, sociology, statistics, and urban planning and policy development. There are no language or residency requirements for the degree.

A dual master's degree program is available with the graduate programs in urban planning and policy development. This track leads to a master of science degree in agricultural economics and either a master of science in urban planning and policy development or a master of city and regional planning. Students are accepted independently into both graduate programs after making separate applications to each. Students must meet the requirements of both programs. However, with proper course selection, 9 credits of course work from each program may be applied to the other degree.

Applicants to the graduate program in agricultural economics normally are accepted for matriculation only in the fall term of each year. Applicants must submit scores of the general test of the Graduate Record Examination, three letters of recommendation, and a statement of personal objectives. Foreign applicants whose native language is not English also must take the Test of English as a Foreign Language (TOEFL) and should score at a level of approximately 600 or better. For applicants wishing to receive full consideration for financial aid, the application and all supporting credentials should be received by the Office of Graduate Admissions by March 1.

Individuals who have a limited undergraduate background in economics or agricultural economics should complete the following courses before applying to the program: an undergraduate course in intermediate microeconomic theory, calculus (minimum of one, but preferably two terms), and introductory statistics. In a few cases, outstanding students who lack these courses may be admitted on a conditional basis, subject to successful completion of the specified courses. Credits from these courses may not be used to fulfill the requirements of the master's degree. Financial aid is not available to entering students admitted on a conditional basis, although such students subsequently may apply for aid upon completion of conditions imposed at the time of admission.

Details about the program can be found in a brochure entitled *Graduate Program in Agricultural Economics,* which is available upon request from the office of the graduate director.

Graduate Courses

16:395:502. (F) INTERNATIONAL AGRICULTURAL DEVELOPMENT (3)
  Pray
The role of agriculture in economic development of low-income nations. Analysis of induced technical and institutional innovations, human capital investments, and public policies to promote development.

16:395:503. (F) RESEARCH METHODS (3)
  Pray
The scientific method and applied research in economics. Planning of research, including problem definition and preparation of research proposals. Overview of commonly used analytical techniques.

16:395:504. (S) INDUSTRIAL ORGANIZATION OF FOOD INDUSTRIES (3)
  Bhuyan
Firm organization and behavior in the U.S. food marketing system. Structure-conduct-performance, strategic behavior (game theory), price discrimination, integration, welfare analysis of noncompetitive markets.

16:395:505. (F) MICROECONOMIC THEORY WITH APPLICATIONS (3)
Theories of consumption, production, markets, economic welfare, and efficiency, with empirical applications.

16:395:506. (S) APPLIED ECONOMETRICS (3)
  Hossain
Applications of econometrics to agricultural demand and price-related problems. Specification, estimation, and verification of single equation and simultaneous equation models. Topics include multicollinearity, autocorrelation, heteroschedasticity, dummy variables, analysis of variance, time series analysis and forecasting, and specification error.

16:395:507,508. (F,S) AGRICULTURAL ECONOMICS WORKSHOP (1.5,1.5)
Critical evaluation of the current research of faculty, graduate students, and invited scholars.

16:395:509. (S) ENVIRONMENTAL AND RESOURCE ECONOMICS (3)
  Parks
Externalities, public goods, and causes of environmental problems. Efficiency and welfare aspects of environmental policies. Common property resource problems and optimum extraction rates for renewable and nonrenewable resources.

16:395:510. (S) AGRIBUSINESS MARKETING RESEARCH (3)
Experience in formulating and conducting a relevant and meaningful agribusiness marketing research project.

16:395:511,512. (F,S) CONTEMPORARY TOPICS IN AGRICULTURAL ECONOMICS (3,3)
  Bhuyan
Economic theory as it relates to problems in agriculture and environmental and resource economics.

16:395:620. INDEPENDENT STUDY IN AGRICULTURAL ECONOMICS (3)

16:395:701,702. RESEARCH IN AGRICULTURAL ECONOMICS (BA,BA)
Research topic approved by graduate committee.

FOOD SCIENCE 400

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Chi-Tang Ho, 107 Food Science Building, Cook Campus (732/932-9611, ext. 207)**

Members of the Graduate Faculty

George M. Carman, *Professor of Food Science, CC; Ph.D., Massachusetts*
  Biochemistry; membranes, phospholipids, and enzymes
Suzie Chen, *Associate Professor of Chemical Biology, EMSP; Ph.D., Albert Einstein College of Medicine*
  Mechanics of cell differentiation and carcinogenesis
Michael Chikindas, *Assistant Professor of Food Science, CC; Ph.D., Institute of Genetics and Selection of Industrial Microorganisms (Russia)*
  Microbiology; genetics; biotechnology; antimicrobial peptides
Henryk Daun, *Professor of Food Science, CC; Ph.D., Politechnika Gdanska*
  Chemistry of food colors; thermal degradation of foods
Chaim Frenkel, *Professor of Horticulture, CC; Ph.D., Washington State*
  Postharvest biology: senescence science, fruit ripening, and stress
Michael Gallo, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Albany Medical College*
  Food additives; phototoxins; dermatotoxicology
Thomas G. Hartman, *Adjunct Research Professor of Food Science and Mass Spectrometry Lab Manager, CAFT; CC; Ph.D., Rutgers*
  Advanced instrumental analytical techniques as applied to food chemistry, mass spectrometry, chromatography, infrared spectroscopy, toxicology
Chi-Tang Ho, *Professor of Food Science, CC; Ph.D., Washington*
  Flavor, chemistry, natural products
Qingrong Huang, *Assistant Professor of Food Science, CC; Ph.D., Nebraska*
  DNA/protein chips; food delivery systems; nanotechnology
Mukund V. Karwe, *Associate Professor of Food Science, CC; Ph.D., Rutgers*
  Numerical simulation of thermal transport in extrusion processes; instrumentation of extruders, laser Doppler anemometry
Jozef Kokini, *Professor of Food Science, CC; Ph.D., Carnegie Mellon*
  Food rheology; biophysical properties, extrusion
Paul A. Lachance, *Professor of Food Science, CC; Ph.D., Ottawa*
  Nutrition; nutritional aspects of food processing
Tung-Ching Lee, *Professor of Food Science, CC; Ph.D., California (Davis)*
  Food chemistry and biochemistry; biotechnological applications in food processing; seafood technology; nutritional and safety aspects of food processing
Thomas Leustek, *Professor of Biochemistry and Microbiology, CC; Ph.D., Rutgers*
  Nutritional value of plant crops, sulfur metabolism; molecular genetics and biochemistry
Richard D. Ludescher, *Associate Professor of Food Science, CC; Ph.D., Oregon*
  Food biophysics; protein chemistry; optical luminescence
Karl Matthews, *Associate Professor of Food Science, CC; Ph.D., Kentucky*
  Pathogenesis and reservoirs of foodborne pathogens
Thomas J. Montville, *Professor of Food Science, CC; Ph.D., Massachusetts Institute of Technology*
  Microbial food safety; fermentations; biotechnology
Mohamed M. Rafi, *Assistant Professor of Food Science, CC; Ph.D., Kerala*
  Biochemistry; nutragenomics; molecular and cellular mechanisms of health promoting nutraceuticals from foods and medicinal plants
Joseph D. Rosen, *Professor of Food Science, CC; Ph.D., Rutgers*
  Food chemistry; toxicology; mass spectrometry
Robert T. Rosen, *Adjunct Research Professor of Food Science and Associate Director, CAFT; Ph.D., Rutgers*
  Analytical and food chemistry; mass spectrometry; instrumental analysis; natural products; chromatography

Donald W. Schaffner, *Extension Specialist in Food Science, CC;*
Ph.D., Georgia
Predictive food microbiology; quantitative microbial risk assessment

Karen M. Schaich, *Associate Professor of Food Science, CC; Sc.D.,*
Massachusetts Institute of Technology
EPR studies of free radicals; lipid oxidation; co-oxidation of macromolecules;
chemistry of antioxidants

Paul Takhistov, *Associate Professor of Food Science, CC; Ph.D.,*
USSR Academy of Science
Nonthermal food processing; biofilms; biosensors; nanotechnology

Beverly J. Tepper, *Associate Professor of Food Science, CC; Ph.D., Tufts*
Nutrition; food intake regulation; sensory evaluation; taste in disease

Shaw S. Wang, *Professor of Chemical and Biochemical Engineering, SE;*
Ph.D., Rutgers
Biochemical engineering; food science and technology

Kit L. Yam, *Associate Professor of Food Science, CC; Ph.D., Michigan State*
Food packaging engineering, polymeric material

Chung S. Yang, *Professor of Pharmacognosy, EMSP; Ph.D., Cornell*
Cancer prevention by dietary constituents; molecular and cellular mechanisms
of carcinogenesis

Adjunct Members of the Graduate Faculty

Gail V. Civille, *President, Sensory Spectrum, Inc.; B.S., College of Mount*
Saint Vincent
Sensory evaluation of foods; methodology

Dennis R. Heldman, *Visiting Professor of Food Engineering; Ph.D.,*
Michigan State
Mathematical models for prediction of thermophysical properties of food based on
composition; process design

Programs

The following areas of specialization are offered: basic studies in physical, chemical, or biological changes in foods; chemistry of fats and oils; flavor chemistry, including isolation and identification of food flavors; chemistry of food proteins; nutritional aspects of food products; food enzymology and biochemistry; food microbiology; food toxicology; heat and mass transfer in foods, energy conservation in processing; food packaging, theoretical aspects, functionality, and properties; food colors; food emulsions; sensory attributes of foods; and biotechnology. The program is suitable for part-time study.

Applicants are expected to have completed one year each of calculus, physics, and organic chemistry, and to have some foundation in the biological sciences. Biochemistry, microbiology, and/or nutrition are recommended, as is statistics. Some undergraduate food science courses may be taken for graduate credit. The Graduate Record Examination must be taken.

Food science offers a master of science degree with options for a thesis or nonthesis program. In the thesis option, the student must take a minimum of 6 research credits and 24 course credits, and must carry out a research problem and write a thesis. For the nonthesis option, the student must have a minimum of 30 course credits and must present an essay. A nonthesis M.S. normally is considered a terminal degree. However, the student with the support of his or her major adviser may petition the faculty for permission to continue with the Ph.D. program.

The student should demonstrate proficiency in food science by the satisfactory completion of course work in the following areas: food science fundamentals, food science seminar (1 credit), food biochemistry, food engineering, nutrition, food analysis or quantitative analysis, and food microbiology. Any of the above requirements may be waived, except seminars, if the student has had courses that satisfy the core requirements.

Students must demonstrate proficiency in food biology, food chemistry, and food engineering early in their academic careers. They are required to complete with an average grade of *B* or better 16:400:507 Food Engineering Fundamentals and Processes and 16:400:513,514 Food Science Fundamentals I,II.

The Ph.D. requires a minimum of 72 credits beyond the bachelor's degree, of which 45 must be course credits. Candidates who have any deficiencies upon admission are required to make up these deficiencies before receiving the degree.

Qualifying examinations for the doctorate include both written and oral examinations. A student must take a written qualifying examination in one of the following areas: food biology, food chemistry, or food physics/engineering. After passing the

written qualifying examination, the student takes the oral qualifying examination, which normally includes approval of the research proposal for the dissertation. A student who fails all or part of the written qualifying examination may, with the concurrence of the faculty and his or her adviser, retake one time those portions of the examination that he or she failed. Likewise, a student who does not pass the oral qualifying examination may retake the examination once, with the dissertation committee's concurrence. After passing both the written and oral components of the qualifying examination, the student is recommended as a candidate for the Ph.D. There is no language or residence requirement for the Ph.D. degree.

The master of philosophy degree is an option for doctoral candidates. Graduate assistantships, teaching assistantships, and fellowships are available to qualified students.

Academic and research training in packaging science and engineering as applicable to food is possible in this program. For further information concerning this option, refer to the listing under Packaging Science and Engineering in this chapter.

Graduate Courses

16:400:501. (F) FLAVOR CHEMISTRY (3)
Ho. Prerequisite: One year of organic chemistry or equivalent.
Isolation, fractionation, and identification of the desirable and objectionable flavor constituents in food; chemical mechanisms for the formation of flavor components in food; methods for measuring flavor and flavor stability of food and food components; manufacture of food flavors.

16:400:502. (F) FOOD SCIENCE INSTRUMENTATION (3)
Hartman, Ho, R. Rosen. Prerequisite: Organic chemistry.
Theory, methodology, and application of chromatographic methods, including high-performance liquid, thin-layer, and gas chromatography. Theory, methodology, and application of spectrometry, including visible color, ultraviolet, infrared, NMR, and mass spectrometry.

16:400:504. (S) CARBOHYDRATES IN FOODS (3)
Prerequisite: Organic chemistry.
The basic chemistry and technology of carbohydrates in food products. Functional properties of carbohydrates are related to their structures and uses in food systems, with an emphasis on industrial gums.

16:400:505. (S) LIPID CHEMISTRY (4)
Schaich. Prerequisite: 16:400:513 or permission of instructor.
Structure and composition of lipids; chemical and physical properties; lipid structures in foods and biological materials; processing of fats and oils; fractionation, purification, and analysis of lipids; chemistry of degradation, autoxidation, pro-and anti-oxidants; emulsions and emulsifiers; membranes; health effects and physiology of lipids.

16:400:506. (S) CHEMISTRY OF FOOD PROTEINS (3)
Ludescher. Prerequisite: 16:400:513.
Study of the molecular structure, physical chemical properties, and functions of proteins and their constituents. Special emphasis on the relationship between molecular structure and function in food proteins.

16:400:507. (S) FOOD ENGINEERING FUNDAMENTALS AND PROCESSES (4)
Karwe. Prerequisites: Physics, calculus.
Principles of material and energy balance, thermodynamics, fluid flow, and heat and mass transfer. Review of unit operations: thermal processing, refrigeration, freezing, evaporation, dehydration, extraction, filtration, membrane processes. Introduction to microwave, high pressure, and pulsed electric field processing.

16:400:510. (S) FOOD RHEOLOGY (3)
Kokini. Prerequisites: 16:400:507, 517.
Concepts of flow and deformation behavior and their application in food materials. Rheological properties for liquid and solid materials. Methods of measurement of rheological properties in food systems. Rheology stability and rheology texture relationships used to illustrate applications of rheology in product quality. Basic equations of fluid flow and their application in selected flow processes such as extrusion and spinning.

16:400:511. (S) FOOD ENZYMOLOGY (3)
Carman. Prerequisites: General biochemistry, 16:400:513,514.
Methods of measuring enzymatic activities; extraction of enzymes from microbial, plant, and animal systems; methods of enzyme purification and characterization; and regulation of enzyme activities by activators, inhibitors, and by covalent modification. Enzymes used by the food industry and methods for controlling endogenous enzyme activities.

16:400:512. (S) BIOREGULATION AND BIOTECHNOLOGY IN FOOD FERMENTATION (3)
Montville. Prerequisites: 16:400:513, 514 or permission of instructor.
Utilization and physiology of microorganisms in the food industry. Metabolic regulation of fermentation products. Fermentors as laboratory tools, new microbial technologies, and approaches to the use of microorganisms in foods.

16:400:513. (F) FOOD SCIENCE FUNDAMENTALS I (3)
Lee, et al. Prerequisite: Organic chemistry.
Basic chemistry of carbohydrates, proteins, lipids, vitamins, and water independent of and in relation to interaction during processing.

16:400:514. (S) FOOD SCIENCE FUNDAMENTALS II (3)
Matthews. Prerequisite: General microbiology or biochemistry.
Mechanistic examinations of foodborne microbes, enzymology, biotechnology, postharvest physiology, nutrition, and current concepts in food safety as related to food composition and processing.

16:400:515. (F) PRINCIPLES OF FOOD PROCESS ENGINEERING I (3)
Heldman. Prerequisites: 11:400:401,402 and a year of calculus, or equivalent.
Applications of kinetic models to microbial growth and inactivation, as well as quality attributes in foods. Influence of temperature, water activity, and phase change on reaction rates. Use of transient-state heat and mass transfer to describe temperature and water activity distribution histories within foods during typical preservation processes. Integration of kinetic models and temperature/water activity distributions into models for prediction of microbial safety and product quality as function of process conditions and/or storage environment.

16:400:517. (F) APPLIED MATHEMATICS IN FOOD SCIENCE (3)
Heldman. Prerequisites: 11:400:401, 402 or 16:400:507 and a year of calculus or equivalent.
Applications of numerical methods to solution of problems encountered in food science. Linear analysis and matrices, functions of single and multiple variables, solutions to ordinary and partial differential equations, and data analysis and modeling. Applications to heat and mass transfer problems in food systems during phase change. Software packages.

16:400:519. (F) FOOD SAFETY (3)
J. Rosen. Prerequisite: Organic chemistry.
Chemistry and toxicology of food additives, pesticides, mycotoxins, and materials naturally present in food. Chemical carcinogenesis. Role of diet in both cancer causation and cancer inhibition.

16:400:521. (F) CHEMISTRY OF FOOD COLORS (3)
Daun. Prerequisites: Organic chemistry, physics.
Occurrence, structure, and physical and chemical properties of synthetic and natural food colors. Interactions between color substances and other food components during processing and storage. Analytical aspects of food colors.

16:400:526. (F) PREDICTING SHELF LIFE OF FOODS (3)
Yam. Prerequisite: B.S. degree in food science, chemistry, or a related field.
The concept of shelf life, factors affecting shelf life, and strategies for shelf life extension. Applications of chemical and microbial kinetics to quantify food deteriorative reactions, mass transfer theories to quantify the movement of gases and vapors through package, and basic calculus to develop predictive shelf life models. Case studies and computer programs.

16:400:530. (S) ADVANCED FOOD SENSORY SCIENCE (3)
Tepper. Prerequisites: 01:960:401 or equivalent; basic physiology; nutrition.
In-depth study of the principles of sensory physiology, taste psychophysics, and sensory evaluation with emphasis on food and food constituents and the various methods of product testing. Includes laboratory exercises.

16:400:592. (S) ADVANCED MASS TRANSFER IN FOOD SYSTEMS (3)
Liu. Prerequisites: College physics, organic chemistry, and college math including calculus, or permission of instructor.
Fundamentals of mass transfer in various food and food processing systems. Diffusions in solids, liquids, vapors, polymer films, and diffusions coupled with heat transfer and/or chemical reactions. Special processes and phenomena: absorption, extraction, spray drying, membrane separations, and controlled release.

16:400:601,602. SEMINAR IN FOOD SCIENCE (1,1)
Required of all students.
Student and guest speakers. Topics presented contribute to some facet of food science. Student participation is focused on providing experience in preparing, presenting, and defending scholarly research.

16:400:603. SPECIAL TOPICS IN FOOD SCIENCE (BA)
Conference 3 hrs.
Designed to permit a student to work on a relatively short-term library or laboratory project and prepare a final annotated paper, or to elect a specially arranged course of a visiting investigator.

16:400:605. (F) MICROBIAL FOOD SAFETY (3)
Matthews. Prerequisites: 01:119:390 and 11:126:302 or equivalent.
Traditional and emerging pathogens, behavior (phenotypic and genetic) in food systems and host(s); government and industry regulations.

16:400:606. (F) FOOD PACKAGING SCIENCE AND TECHNOLOGY (3)
Yam. Prerequisite: B.S. degree in food science, chemistry, or related field.
Packaging material science and applications, package systems analysis, modified atmosphere packaging, aseptic food packaging, microwavable food packaging, active and intelligent packaging, package and the environment, and regulatory aspects of food packaging.

16:400:609. (F) THERMAL AND NONTHERMAL PROCESSING OF FOODS (3)
Karwe. Prerequisites: Undergraduate or graduate degree in any of the following: food science, chemical engineering, mechanical engineering, physical sciences. Some knowledge of simple programming (BASIC, Excel, Fortran, MatLab).
Topics: heat sterilization/canning/retorting, UHT, aseptic processing, frying, baking, ohmic heating, microwave heating, extrusion, high hydrostatic pressure, pulsed electric, pulsed light, oscillating magnetic field, irradiation.

16:400:610. (S) NUTRAGENOMICS AND NUTRACEUTICALS (3)
Rafi. Prerequisite: 16:400:514 or biochemistry or permission of instructor.
Host-immune responses in diseases, signal transduction pathways in cancer and inflammation, transcription factors, proteomics, bioavailability of nutraceuticals, signaling molecules and their interactions with nutraceuticals. Role of nutraceuticals in health promotion and its mechanism of action. Isolation and identification of health promoting nutraceuticals and separation techniques. Beneficial and questionable effects of nutraceuticals and the development of future foods.

16:400:611. (S) POLYMERIC PROPERTIES IN FOOD (3)
   Kokini. Prerequisites: 16:400:507, 510, 517.
Polymeric properties of biological materials, organization of macromolecules in the form of food; physical and physico-chemical properties and their quantitative treatment; quantitative design principles for the structure and organization of food.

16:400:612. (F) COLLOIDAL CHEMISTRY OF FOOD (3)
   Takhistov. Prerequisites: Calculus I, physical chemistry, or permission of instructor.
Principles of colloid and interface science. Analysis and design of the biocolloidal, food, and various natural dispersion systems in the context of fundamental physico-chemical interactions between surfaces/phases. Major course topics are: suspensions, emulsions, foams, and biocolloids (cell/cell and cell/surface interactions).

16:400:613. (F) NANOTECHNOLOGY AND ITS APPLICATIONS IN BIOTECHNOLOGY AND FOOD (3)
   Huang. Prerequisites: Physical chemistry or permission of instructor
Basic concepts, investigation tools, and fundamental issues of nanotechnology, with emphasis on the applications of nanotechnology in agricultural and food systems, healthcare, food safety, and food packaging. Self-assembly, scanning probe microscopy, micro- and nanoencapulation, organic/inorganic nanocomposites, DNA, and protein chips.

16:400:701,702. RESEARCH IN FOOD SCIENCE (BA,BA)

FRENCH 420

Degree Programs Offered: **Master of Arts, Master of Arts for Teachers, Doctor of Philosophy**
Director of Graduate Program: **Professor François Cornilliat,**
  103 Ruth Adams Building, Douglass Campus
  (732/932-8223/3750)
Web Site: *http://french.rutgers edu*

Members of the Graduate Faculty

Carole Allamand, *Assistant Professor of French, FAS–NB; Ph.D., Cornell*
   Twentieth-century literature
François Cornilliat, *Professor of French, FAS–NB; Doctorat d'Etat, Paris VIII*
   Sixteenth-century literature; rhetoric and poetics
Viviane M. Deprez, *Associate Professor of French and Linguistics, FAS–NB;*
   Ph.D., Massachusetts Institute of Technology
   Linguistics; phonetics
M. Josephine Diamond, *Professor of French, FAS–NB; Ph.D., Cornell*
   Nineteenth- and 20th-century literature; critical theory
Uri A. Eisenzweig, *Professor of French, FAS–NB; Doctorat Habilitation, Paris VIII*
   Nineteenth- and 20th-century literature; critical theory
Jerry Aline Flieger, *Professor of French, FAS–NB; Ph.D., California (Berkeley)*
   Twentieth-century literature; critical theory; women's studies and feminist theory
Josephine Grieder, *Professor of French, FAS–N; Ph.D., New York*
   Eighteenth-century literature; social history
Louise K. Horowitz, *Professor of French, FAS–C; Ph.D., CUNY*
   Seventeenth-century literature
Renée B. Larrier, *Associate Professor of French, FAS–NB; Ph.D., Columbia*
   African and Caribbean literature in French
Richard D. Lockwood, *Chairperson and Associate Professor of French, FAS–NB;*
   Ph.D., Johns Hopkins
   Seventeenth-century literature; rhetoric; critical theory
Ana Pairet, *Associate Professor of French, FAS–NB; Ph.D., Pennsylvania*
   Late medieval literature
Lorraine Piroux, *Assistant Professor of French, FAS–NB; Ph.D., Northwestern*
   Eighteenth-century literature
Derek Schilling, *Assistant Professor of French, FAS–NB; Ph.D., Pennsylvania;*
   Doctorat, Paris VIII
   Twentieth-century literature, cultural poetics, urbanism
Richard Serrano, *Assistant Professor of French, FAS–NB; Ph.D.,*
   California (Berkeley)
   Literature of the Maghreb; 20th-century literature
Mary Lewis Shaw, *Associate Professor of French, FAS–NB; Ph.D., Columbia*
   Nineteenth- and 20th-century literature; performance arts
Mary B. Speer, *Professor of French, FAS–NB; Ph.D., Princeton*
   Medieval language and literature; theory and practice of editing
James Swenson, *Associate Professor of French, FAS–NB; Ph.D., Yale*
   Eighteenth-century literature; critical theory
Alan L. Williams, *Professor of French, FAS–NB; Ph.D., SUNY (Buffalo)*
   Film history; film theory; literary theory; contemporary French literature

Associate Members of the Graduate Faculty

Geneviève Fraisse, *Research Director, Centre National de la Recherche*
   Scientifique; Doctorat d'Etat, Ecole des Hautes Etudes en Sciences Sociales
   History of ideas; history and theory of feminism
Claude Mouchard, *Professor Emeritus of French Literature, Paris VIII;*
   Habilitation, Paris VIII
   Poetry, 19th-century literature; comparative literature; translation
Jacques Rancière, *Professor Emeritus of Philosophy, Paris VIII; Doctorat d'Etat,*
   Paris I
   Aesthetics; poetics and politics

Programs

The M.A. and Ph.D. programs deal with all-important aspects of French literature and some related fields through a variety of critical approaches. These programs are open to candidates whose academic records and Graduate Record Examination scores give evidence of distinguished accomplishment and promise of successful graduate work.

Applications for September admission to the M.A. and Ph.D. programs should be submitted by February 1 in order to receive full consideration for financial aid.

The M.A.T. program in French studies is designed primarily for persons already involved in teaching French or using their knowledge of French and French culture in some professional capacity. Candidates for the M.A.T. are admitted on the basis of formal background and professional activity and need not submit Graduate Record Examination scores.

An application for the M.A.T. program is normally considered only after the student has completed one summer of course work (a minimum of two 3-credit courses) in the Rutgers summer World Languages Institute. Nonmatriculated students may take these courses.

Candidates for the M.A. must satisfactorily complete 30 credits of course work (6 of which may be devoted to a research problem if the candidate elects to write a thesis). In addition, they must pass an examination based on course work and a reading list. Those who wish to continue toward the Ph.D. are screened for that program at the time of the M.A. examination.

Candidates for the M.A.T. also take 10 courses, offered primarily in the summer by the World Languages Institute. Any M.A.T. student wishing to take courses during the regular academic year (whether graduate or undergraduate) may do so with the permission of the graduate director.

Doctoral candidates are required to complete 48 credits of course work beyond the bachelor's degree (54 credits for transliteratures fellowship students, who are required to take an extra two courses in another language). Credit for graduate work taken at other institutions may be accepted in partial fulfillment of the course requirement, but in no case will the doctoral candidate do less than one full year of course work (24 credits) at Rutgers.

Prospective candidates for the Ph.D. degree fulfill the residence requirement through full-time commitment to course work and/or research during two consecutive terms, excluding Summer Session. Doctoral candidates must demonstrate by examination a reading knowledge of two foreign languages in addition to French. These languages usually include a Romance language and either German or Latin, but substitution of a different language on the basis of relevance to projected research is possible. Greater proficiency in one language, proven by the successful completion of 6 credits of graduate course work in the literature of that language, may replace the second language requirement. The Ph.D. qualifying examination provides a head start on doctoral research and leads directly to the dissertation. It requires the development of a research field and the writing of a dissertation proposal, under the supervision of faculty advisers. The examination consists of three parts (two oral and one written), which are taken separately. The first two parts focus on two contiguous periods of specialization or on one such period and criticism and theory. The third part is a final oral exam on the student's chosen research field. It has to be taken last (i.e., after 48 or 54 credits of course work have been completed, the language requirements have been met, and the first two parts have been passed), as it is the part leading directly to the dissertation.

Reading lists upon which the examinations are based, as well as the *Guide to the French Graduate Program,* are available in the department office or on the department's web site. The graduate program in French participates in the Transliterature Program (q.u.).

Graduate Courses

16:420:500. INTRODUCTION TO RHETORICAL AND STYLISTIC ANALYSIS (3)
Cornilliat, Eisenzweig
Techniques of literary interpretation of prose fiction, theater, and poetry. Critical readings and analyses of selected texts.

16:420:502. PHONETICS (3)
Deprez
Theory and practice of French phonetics with emphasis on pedagogical approaches. Special attention to regional, social, and cultural influences on the production of speech.

16:420:503. ADVANCED GRAMMAR, STYLISTICS, AND THEORY OF LANGUAGE (3)
Deprez
Advanced French grammar and theory of language with special attention to typical problems of idiomatic expression; themes, oral presentations, and translation exercises.

16:420:504. TRANSLATION (3)
Translation as a linguistic, cultural, and creative exchange of signs from one language into another. Intensive practice in oral and written translation from literary, journalistic, and official sources.

16:420:505. STUDIES IN CONTEMPORARY FRENCH CULTURE (3)
Aspects of French society, history, geography, economy, intellectual and artistic life; institutions, codes of behavior, and patterns of thought; Franco-American relations and influences.

16:420:508. STUDIES IN FRANCOPHONE CULTURE (3)
Allamand, Diamond, Larrier, Serrano
Civilization and literatures of French-speaking Africa and America. Overviews and close examinations of the society, language, and literature of places as diverse as Sénégal, Haïti, and Québec.

16:420:509,510. TOPICS IN FRENCH LITERATURE FOR TEACHERS OF FRENCH (3,3)
Approaches to French literature of various periods, genres, or themes appropriate for adaptation to secondary school curricula.

16:420:511. METHODOLOGY OF LANGUAGE TEACHING (3)
Methods of teaching language. Theories of second language acquisition and applications for either college or K–12 teaching.

16:420:512. TEACHING APPRENTICESHIP IN FRENCH (N1)
Observation of elementary and intermediate language classes; supervised practice teaching.

16:420:513. HISTORY OF THE FRENCH LANGUAGE (3)
Pairet, Speer
Development of the French language from its origins to the present. Consideration of the cultural forces that have influenced linguistic evolution in France.

16:420:514. FRENCH ACROSS THE CURRICULUM (3)
Methods, materials, and language skills for teaching school-children in French in a variety of disciplines. Development of teaching materials and application of national standards in the foreign language classroom.

16:420:516. STUDIES IN FRENCH FILM (3)
Williams
Approaches to the French cinema or its history as an expression of a literary or cultural theme.

16:420:601,602. INDIVIDUAL STUDIES IN FRENCH LITERATURE AND THEORY (3,3)
Available only by special arrangement with permission of the graduate adviser.
Independent study course of directed readings in areas of particular interest, such as linguistics, critical theory, cinema studies, and studies of individual genres or issues.

16:420:611,612. OLD FRENCH LANGUAGE AND LITERATURE (3,3)
Pairet, Speer
Readings of selections from the various forms and periods of medieval French literature, with an introductory study of French philology.

16:420:613. MEDIEVAL FRENCH ROMANCE (3)
Pairet, Speer
Selected works and authors, with attention to linguistic problems as well as to medieval and contemporary critical approaches.

16:420:614. MEDIEVAL LYRIC POETRY (3)
Pairet, Speer
Reading and analysis of selected poems, authors, or genres in medieval French and/or Occitan.

16:420:615,616. STUDIES IN MEDIEVAL FRENCH LITERATURE (3,3)
Pairet, Speer
Intensive study of a medieval genre, theme, author, or major work; literary and linguistic analysis; problems of textual criticism.

16:420:621,622. FRENCH LITERATURE OF THE RENAISSANCE (3,3)
Cornilliat
Introduction to the principal ideological and aesthetic currents of the 16th century through selected texts by the major poets (Marot, Scève, Labé, DuBellay, Ronsard, and D'Aubigné) and prose writers (Rabelais, Marguerite de Navarre, and Montaigne).

16:420:623. RABELAIS (3)
Cornilliat
Rabelais as humanist and storyteller; problems of language and the narrative in the early French Renaissance.

16:420:624. POETRY OF THE FRENCH RENAISSANCE (3)
Cornilliat
Jean Lemaire, Clément Marot; the School of Lyons; the Pléiade; scientific and satirical poets of the century's end.

16:420:625. MONTAIGNE (3)
Cornilliat
Critical reading of the *Essais* with attention to the dynamics of form and meaning.

16:420:631,632. FRENCH LITERATURE OF THE 17TH CENTURY (3,3)
Horowitz, Lockwood
Against the background of the age, a study of the main literary currents and an analysis of some of the significant works of the major writers.

16:420:633. THE CLASSICAL THEATER (3)
Horowitz, Lockwood
Intensive study of the forms, rhetoric, and meaning of the plays of Corneille, Racine, and Molière.

16:420:634. LA FONTAINE AND THE MORALISTES (3)
Horowitz, Lockwood
Study of LaRochefoucauld, LaFontaine, Pascal, Sévigné, LaFayette, Boileau, Perrault, or other selected writers whose work addresses moral, social, or political issues, with particular attention to rhetoric and subjectivity.

16:420:636. PASCAL (3)
Lockwood
Intensive study of problems in Pascal and Pascal criticism.

16:420:637,638. Studies in French Literature of the 17th Century (3,3)
Horowitz, Lockwood
Intensive study of a major figure, theme, movement, or single work.

16:420:641,642. French Literature of the 18th Century (3,3)
Grieder, Piroux, Swenson
The rise and development of new literary forms and their relationship to intellectual and social changes of the Enlightenment.

16:420:643. Diderot (3)
Piroux, Swenson
Major works and editorial activity, with emphasis on the variety of forms and genres, development of aesthetic theory, and materialist epistemology and ethics.

16:420:644. Rousseau (3)
Piroux, Swenson
Major works, particularly *Confessions, Emile, LaNouvelle Heloise,* and *Social Contract.* Consideration of Rousseau's reception and influence in both literary and political developments.

16:420:645,646. Studies in 18th-Century French Literature (3,3)
Piroux, Swenson
Intensive study of a theme, period concept, stylistic practice, or major figure of the French Enlightenment.

16:420:651,652. French Literature of the 19th Century (3,3)
Diamond, Eisenzweig, Mouchard, Rancière, Shaw
Study of the main literary currents; analysis of significant works by major writers, with emphasis on cultural history and the evolution of art forms.

16:420:653. French Romanticism (3)
Diamond, Eisenzweig, Mouchard, Rancière, Shaw
Study of the movement from a theoretical and historical perspective, with an emphasis on one or more major authors or works.

16:420:654. Nineteenth-Century French Poetry (3)
Diamond, Mouchard, Shaw
Intensive study of a poetic movement (romanticism, symbolism), or of one or more major poets.

16:420:655. The 19th-Century French Novel (3)
Diamond, Eisenzweig, Mouchard, Rancière
Intensive study of one or more major authors or works, with emphasis on theoretical and aesthetic perspectives.

16:420:657. Fin de Siècle France (3)
Eisenzweig, Shaw
An unusual moment in literary history, observed through the study of one or more major authors, works, events, or of the period as a whole.

16:420:659,660. Studies in 19th-Century French Literature (3,3)
Diamond, Eisenzweig, Mouchard, Rancière, Shaw
Intensive study of a movement, a genre, one or more major authors or works, or of a specific theoretical or thematic topic.

16:420:661,662. French Literature of the 20th Century (3,3)
Allamand, Eisenzweig, Flieger, Mouchard, Schilling, Shaw
Survey of the main literary currents; analysis of significant works by major writers.

16:420:663. French Theater of the 20th Century (3)
Allamand, Flieger, Schilling, Shaw
Study of major authors and works from Claudel to Holtes, with emphasis on the theory and practice of performance.

16:420:664. Twentieth-Century French Poetry (3)
Study of major authors and works from Apollinaire to the contemporary poetic scene.

16:420:665. The 20th-Century French Novel (3)
Allamand, Flieger, Schilling
Study of major authors and works, with emphasis on the critique and evolution of the genre.

16:420:667. Intellectual and Aesthetic Movements of the 20th Century (3)
Allamand, Eisenzweig, Flieger, Fraisse, Schilling
Studies in literature and philosophy; literature and politics; and the role of the intellectual.

16:420:669,670. Studies in French Literature of the 20th Century (3,3)
Allamand, Eisenzweig, Flieger, Mouchard, Schilling, Shaw
Intensive study of a major writer, concept, or theme.

16:420:671. Sub-Saharan African Literature (3)
Larrier, Serrano
Study of literature in French by major writers from West and Central Africa.

16:420:672. North African Literature (3)
Serrano
Study of literature in French by major writers from the Maghreb.

16:420:673. Caribbean Literature (3)
Larrier
Study of literature in French by major writers from the Caraibes and French Guiana.

16:420:674. Francophone Literatures in Europe and North America (3)
Allamand
Study of major Francophone writers from Belgium, Switzerland, or Quebec and other regions of Canada.

16:420:675. Studies in Francophone Literature (3)
Allamand, Larrier, Serrano
Intensive study of a theme, movement, genre, or culture, with special emphasis on comparative contexts.

16:420:677,678. History of the French Cinema (3,3)
Williams
History of the French cinema from Lumiere and Melies to the New Wave and beyond.

16:420:679. Studies in Filmand Film Theory (3)
Williams
Intensive study of one or more movements, authors, or genres, with emphasis on critical approaches and theoretical issues.

16:420:681. French Rhetoric and Poetics (3)
Cornilliat, Lockwood
Evolution of rhetoric and poetics and their application to literature from the Renaissance to modern times.

16:420:682. Perspectives of Contemporary Criticism (3)
Diamond, Eisenzweig, Flieger, Swenson
The New French Criticism: theory and models of the phenomenological, structuralist, generative, or poststructural enterprise.

16:420:683,684. Topics in Theory (3,3)
Diamond, Eisenzweig, Flieger, Fraisse, Rancière, Swenson. Prerequisite: Introduction to Theory.
Study of individual theorists, theoretical tendencies, or interdisciplinary theoretical approaches, such as Feminist Theory, Psychoanalysis and Literature, Foucault, or Narratology.

16:420:685. Literature and Gender (3)
Diamond, Flieger, Fraisse
Study of intersection of literature, gender, and culture. Topics might include individual writers, specific periods, generic topics, and theoretical problems.

16:420:687,688. TOPICS IN FRENCH LITERATURE **(3,3)**
Analysis of problems or themes across genre and century boundaries.

16:420:691,692,693,694. HALF-TERM PROJECTS **(1.5,1.5,1.5,1.5)**
Half-term courses devoted to an aspect of critical theory, a single literary work, a scholarly or textual problem, or a theme spanning more than one literary period.

16:420:701,702. RESEARCH IN FRENCH **(BA,BA)**

Interdisciplinary Graduate Course

16:195:501. INTRODUCTION TO LITERARY THEORY **(3)**
  Offered under the graduate program in comparative literature.
Introduction to contemporary literary theory, including formalism, structuralism, poststructuralism, feminism, psychoanalysis, cultural studies, and other approaches. Readings of theoretical texts and applications to short literary texts from a variety of literatures.

GEOGRAPHY 450

Degree Programs Offered: **Master of Arts, Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Associate Professor Richard A. Schroeder, Lucy Stone Hall, Livingston Campus (732/445-4107)**
Web Site: *http://geography.rutgers.edu*

Members of the Graduate Faculty

Gail M. Ashley, *Professor of Geological Sciences, FAS–NB; Ph.D., British Columbia*
  Sedimentology; glacial geomorphology; quaternary studies; modern processes
Sean M. DiGiovanna, *Assistant Professor of Urban Studies and Community Health, EJBSPPP/CUPR; Ph.D., Toronto*
  Urban and economic geography, economic development, New Jersey
Michael R. Greenberg, *Professor of Urban Studies and Public Health, EJBSPPP; Ph.D., Columbia*
  Environment and health; mathematical models
Briavel Holcomb, *Professor of Urban Studies, EJBSPPP; Ph.D., Colorado*
  Urban revitalization; gender; tourism
Robert M. Hordon, *Associate Professor of Geography, FAS–NB; Ph.D., Columbia*
  Water resources; physical geography
David M. Hughes, *Assistant Professor of Geography and Human Ecology, FAS–NB; Ph.D., California (Berkeley)*
  Political ecology, development, conservation, colonialism, Southern Africa
Robert W. Lake, *Professor of Urban Planning and Policy Development, CUPR; Ph.D., Chicago*
  Urban restructuring; social and environmental policy analysis; political
Richard G. Lathrop, Jr., *Associate Professor of Environmental Resources, CC; Ph.D., Wisconsin (Madison)*
  Remote sensing and spatial modeling of terrestrial/aquatic ecosystems; GIS
Robin Leichenko, *Assistant Professor of Geography, FAS–NB/CUPR; Ph.D., Pennsylvania State*
  Economic geography; urban and regional development; international trade
Bonnie J. McCay, *Board of Governors Distinguished Service Professor of Human Ecology, CC; Ph.D., Columbia*
  Common property and social theory, fisheries, conservation, North Atlantic
J. Kenneth Mitchell, *Professor of Geography, FAS–NB; Ph.D., Chicago*
  Environmental hazards; human-environment theory; environment and public policy; global environmental change
Karl F. Nordstrom, *Professor of Geography and Marine and Coastal Sciences, CC/IMCS; Ph.D., Rutgers*
  Coastal geomorphology and management; environmental restoration
Frank Popper, *Professor of Urban Studies, EJBSPPP; Ph.D., Harvard*
  Land use, environmental and regional policy; natural resources management
Jasbir K. Puar, *Assistant Professor of Women's and Gender Studies, FAS–NB; Ph.D., California (Berkeley)*
  Feminist and queer geography; globalization; tourism; South Asian diaspora
Edward Ramsamy, *Assistant Professor of Africana Studies, FAS–NB; Ph.D., Rutgers*
  Development, social theory, race, culture and identity, Southern Africa
Joanna M. Regulska, *Professor of Geography and Women's Studies, FAS–NB; Ph.D., Colorado*
  Urban policy; Central and East European restructuring; gender and politics; European union
David A. Robinson, *Professor of Geography, FAS–NB; Ph.D., Columbia*
  Climatology; cryosphere; regional climates; physical geography
Thomas Rudel, *Professor of Sociology, CC; Ph.D., Yale*
  Latin America; environment; development

Dona Schneider, *Associate Professor of Urban Studies and Community Health, EJBSPPP; Ph.D., Rutgers*
  Medical geography; epidemiology; minority health
Richard Schroeder, *Associate Professor of Geography, FAS–NB; Ph.D., California (Berkeley)*
  Development; gender; Africa; political ecology; environmental justice
Kevin St. Martin, *Assistant Professor of Geography, FAS–NB/CUPR; Ph.D., Clark*
  Economic geography; cartography and GIS; resource geography
David Tulloch, *Associate Professor of Landscape Architecture, CC; Ph.D., Wisconsin*
  Geospatial technologies; environmental and land-use planning
Peter O. Wacker, *Professor Emeritus of Geography, FAS–NB; Ph.D., Louisiana State*
  Historical; cultural
Lyna Wiggins, *Associate Professor of Urban Planning and Policy Development, EJBSPPP; Ph.D., California (Berkeley)*
  Geographic information science; computer applications in planning

Associate Member of the Graduate Faculty

Roger C. Balm, *Instructor in Geography; Ph.D., Rutgers*
  Visual culture of geography; history of exploration; art images as evidence

Programs

The graduate program provides students with an understanding of the theory, principles, and research skills needed for geographical inquiry. Students seeking a Ph.D. degree take courses and write a dissertation that is based on original research in a subfield of geography. The program's strengths lie in urban geography and social theory, environmental geography, and physical geography.

Candidates for the master's degree must complete course work, write a thesis worth 6 credits, and complete successfully a comprehensive oral examination. As an alternative, students may write a shorter research paper, take an additional 6 credits of course work, and successfully complete a written and oral examination.

The program faculty has specialties in a broad range of disciplinary subfields. Current research efforts, which include several collaborative projects, range from local to international issues. Following are specific topics:

Urban Geography. Political economy of urban development; comparative urbanization; women and the urban environment; urban restructuring; housing and spatial segregation; gentrification; eastern European urban policy; regional development and decline; uneven global development; cultural historical geography of New Jersey; political geography, space and social theory; and history of geography.

Environmental Geography. Global environmental change, perception of and policy responses to natural and technological hazards, environmental health risks and planning, medical geography, toxic-waste siting, environmental justice, remote sensing of resources and hazards, GIS applications, resource management, land use, remote sensing and political ecology, gender and environment, and development and environment.

Physical Geography. Glacial and periglacial geomorphology, permafrost, sedimentology, quaternary studies, global and regional climate change, cryospheric dynamics, surface radiative dynamics, coastal geomorphology, coastal process-response modeling, coastal management, ground water and water supply, and urban hydrology.

The geography department is linked with various research institutes, programs, and other departments at the university. In addition to core course work in geography, graduate students are encouraged to enroll in courses relevant to their research interests in other units of the university.

For the Ph.D., a minimum of 72 credits is required. Of the total credit load, 48 credits should be in nondissertation course work beyond the bachelor's degree and at least 24 credits should be in dissertation research. In consultation with their advisers, students select a faculty committee. Upon completion of course work, they submit a dissertation proposal and take the qualifying examination.

The master's degree program requires 30 credits beyond a bachelor's degree, with a minimum of 24 of those credits taken in course work. The M.A. degree is awarded to people specializing

in human geography, and the M.S. degree to those who focus on physical geography. A two-course sequence focused on the history and theory of geography and research design and methodology is required for all new students.

Applicants for the graduate program in geography should hold an appropriate, accredited undergraduate degree, although this need not be in geography. Four criteria guide the admissions process: (1) a cumulative grade-point average of 3.25 or better (or equivalent for international students); (2) competitive Graduate Record Examination general test scores; (3) strong letters of recommendation from at least three references; and (4) a persuasive and well-focused personal statement describing academic goals and research interests. Financial support through teaching assistant- ships, graduate assistantships, and university fellowships is avail able on a competitive basis to students with excellent qualifications. Applicants seeking financial aid should submit applications by February 1.

Further information can be obtained from the current edition of the booklet *Graduate Study in Geography at Rutgers University,* available from the department office or by visiting the depart- ment's worldwide web site.

Graduate Courses

16:450:501. (F) INTRODUCTION TO NATURAL RESOURCES MANAGEMENT (3)
Review of recent literature on natural resources management, with emphasis on identifying and analyzing research themes and methodologies employed by contemporary geographers.

16:450:502. (S) RESOURCE MANAGEMENT DECISION MAKING (3)
Prerequisite: 16:450:501 or equivalent.
Individual and collective behavior theories applied to the analysis of private decisions and public natural resource policy, from a human ecological perspective.

16:450:503. (S) ENVIRONMENTAL MANAGEMENT (3)
Prerequisite: 16:450:502 or equivalent.
Contemporary resource management issues in the United States, including resource evaluation, environmental-impact assessment, and planning procedures. Emphasis on conflict resolution, public participation, and the role of science in decision making.

16:450:504. (F) COASTAL GEOMORPHOLOGY (3)
Prerequisite: 01:450:403 or 404 or equivalent.
Erosional and depositional processes in the coastal environment. Process-response models and problem-solving methods in coastal research.

16:450:505. (F) ADVANCED PHYSICAL GEOGRAPHY (3)
Prerequisite: 01:450:403 or 404 or equivalent.
Selected topics within the general field of earth science.

16:450:507. (S) APPLIED GEOMORPHOLOGY (3)
Prerequisite: 01:450:403 or 404 or equivalent.
Applications of modern geomorphological research to environ- mental management, including geomorphological constraints to human activity and human effects on landform processes.

16:450:508. (S) ENVIRONMENTAL PROBLEMS IN DEVELOPING COUNTRIES (3)
Similarities and differences among developing countries in their environmental problems, their definitions of them, and their poli- cies about them. The role of economic development in either solving or causing environmental problems. Environmental considerations in development planning.

16:450:509. (F) HUMAN GEOGRAPHICAL PROBLEMS OF DEVELOPING COUNTRIES (3)
Human underpinnings to problems of development as seen from the perspectives of historical, political, demographic, economic, and social geography. Case studies and examples from the third world.

16:450:510. (S) WATER RESOURCES MANAGEMENT (3)
Problems in the management of water use in metropolitan environ- ments. The effects of urbanization on the hydrologic regime. The influence of geohydrologic factors on water use decisions.

16:450:511. (S) LAND-USE SYSTEMS (3)
Environmental factors in land-use planning. Land-use data sys- tems including storage and retrieval, "third-dimension" planning; water and ground below the surface soil. Multivariate analysis of land variables. Land use and water quality.

16:450:513. (S) SETTLEMENT GEOGRAPHY (3)
Field trips required.
Evolution and morphology of selected rural settlement landscapes interpreted in terms of natural conditions, institutional factors, and economic functions.

16:450:514. ENVIRONMENT AND CULTURE (3)
Interrelations of the environment and cultural practices, knowledge, and ideals. Concepts and methods for studying these interrelations.

16:450:515. (S) POPULATION MIGRATION AND MOBILITY (3)
Analysis of population mobility at the international (immigration, guest workers, refugees), interregional, and intraurban levels through examination of spatial patterns of migration, locational decisions, impact of migrants in places, and population redistribu- tion policies.

16:450:516. (S) URBAN GEOGRAPHY (3)
Geographic aspects of urbanization, theories of contemporary urban geography, and their application to existing urban patterns.

16:450:517,518. DIRECTED STUDY IN GEOGRAPHY (3,3)
Prerequisite: Permission of graduate director.
Directed readings and individual study supplementary to formal courses.

16:450:519. (F) PROBLEMS IN POLITICAL GEOGRAPHY (3)
Geographic implications of state theory, locational conflict, public policy, and national and local government relations.

16:450:520. WOMEN IN THE URBAN ENVIRONMENT (3)
Documentation of the spatial constraints faced by women in the urban environment; examination of women's roots in the context of the interrelation between the activities of production and reproduction.

16:450:521. REGIONAL HYDROLOGY AND LANDFORMS (3)
Relationships between physiographic regions and hydrologic sys- tems. Field trips to regional watersheds in varying landform areas. Land use and water quality.

16:450:522. TOURISM GEOGRAPHY (3)
Geographical aspects of world's leading industry by value. Economic, environmental, cultural, and social impacts of tourism domestically and internationally.

16:450:523. THE CLIMATE SYSTEM AND GLOBAL CLIMATE CHANGE (3)
The earth's energy balance, hydrologic cycle, and atmospheric cir- culation at a variety of spatial and temporal scales. Present climate events and aspects of climate change.

16:450:525. RESTRUCTURING OF CENTRAL AND EASTERN EUROPE AFTER 1989 (3)
Examination of the roots of the collapse of totalitarian regimes in central and eastern Europe. Analyzes spatial implications of the transition for urban development, gender relations, economic restructuring, and environmental change.

16:450:526. PROPERTY THEORY AND POLICY (3)
The problem of private property versus public and common property rights in housing, urban space, and environmental resources, in an international perspective. Policies and practices that determine patterns of ownership, use, economy, and justice in alternative property regimes.

16:450:530. DATA STRUCTURES AND ALGORITHMS FOR SPATIAL PROBLEMS (3)
Prerequisite: 01:450:321 or 420 or 11:372:415.
Discussion and hands-on programming of data structures and algorithms used in geographic information systems.

16:450:533. GEOGRAPHIC INFORMATION IN THE VISUAL ARTS (3)
The visual culture of geography. Images as evidence for the condition of the cultural and physical environment and as determinants of knowledge, cultural values, and territoriality.

16:450:601,602. FIELD AND RESEARCH METHODS IN GEOGRAPHY (3,3)
Research procedures and methods, survey of past and current literature, data collection and analysis, and preparation of reports, papers, and theses; colloquia on analytical problems.

16:450:603. (F) RESEARCH PROSEMINAR (3)
Required for graduate degrees.
Evolution and status of main disciplinary subfields, contemporary paradigms, transdisciplinary relationships, professional employment trends, introduction to geographical bibliography, and basic research skills.

16:450:605,606. GEOGRAPHY SEMINAR (3,3)
Lectures and special problems in current issues. Course content varies according to student and faculty interest.

16:450:607. (S) SEMINAR IN HISTORICAL CULTURAL GEOGRAPHY (3)
Origins and diffusions of selected material and nonmaterial culture traits in North America from the 17th through the 19th centuries.

16:450:612. NATURAL HAZARDS MANAGEMENT (3)
Analysis of human and environmental contributions to the generation and management of natural hazards, including, among others, earthquakes, hurricanes, floods, and droughts. Contemporary public policy issues at national and international levels of government. Theoretical emphasis on decision making in the face of uncertainty.

16:450:613. (F) SEMINAR IN COASTAL RESOURCES GEOGRAPHY (3)
Analysis of contemporary maritime management issues, including ecosystem preservation, siting of energy facilities, ocean dumping, storm-disaster mitigation, port development, waterfront revitalization, and beach recreation. Focus on U.S. and international public policy.

16:450:614. (F) SEMINAR IN MEDICAL GEOGRAPHY (3)
Advanced topics of medical geography. Student research and analysis of specific problems.

16:450:615. (S) SEMINAR IN REMOTE SENSING (3)
Remote sensors and their research capabilities. Research design for remote-sensing studies.

16:450:616. SEMINAR IN TECHNOLOGICAL HAZARDS (3)
Human strategies for managing technological hazards. Development and application of public approaches to technological-hazards management in a global context.

16:450:617. SEMINAR IN REMOTE SENSING OF THE BIOSPHERE (3)
Lathrop. Prerequisite: 16:450:615 or equivalent or permission of instructor.
Application of satellite remote sensing and geographic information system technology to monitor and model the earth's biosphere, including terrestrial/aquatic primary production, biogeochemical cycling, and climate dynamics.

16:450:625. SEMINAR IN GEOGRAPHIC INFORMATION SYSTEMS (3)
Prerequisites: 01:450:420 or 11:372:415.
Advanced topics in geographic information systems: raster/vector data structures, GIS modeling. Requires literature review and hands-on computer analysis.

16:450:632. (S) SEMINAR IN REGIONAL GEOGRAPHY (3)
Selected world regional and interregional problems associated with environmental constraints, natural resource use, and other public policy issues. Varying foreign area focus.

16:450:701,702. RESEARCH IN GEOGRAPHY (BA,BA)

GEOLOGICAL SCIENCES 460

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Kenneth G. Miller,**
 Wright-Rieman Laboratories, Busch Campus (732/445-3622)

Members of the Graduate Faculty

Gail M. Ashley, *Professor of Geological Sciences, FAS–NB; Ph.D., British Columbia*
 Sedimentology; geomorphology; quaternary geology; modern processes
Marie-Pierre Aubry, *Research Professor of Geological Sciences, FAS–NB; D.Sc., Université Pierre et Marie Curie*
 Biostratigraphy; calcareous nannoplankton evolution; geological time and the stratigraphic record
Michael J. Carr, *Professor of Geological Sciences, FAS–NB; Ph.D., Dartmouth*
 Convergent plate margins; volcanology, tectonics, igneous petrology
Jeremy S. Delaney, *Research Scientist, Geological Sciences, FAS–NB; Ph.D., Queens (Belfast)*
 Microbeam analysis of terrestrial and extraterrestrial materials
Paul G. Falkowski, *Professor of Geological Sciences and Marine and Coastal Sciences, FAS–NB; Ph.D., British Columbia*
 Biogeochemical cycles; evolution; astrobiology
Craig S. Feibel, *Assistant Professor of Anthropology and Geological Sciences, FAS–NB; Ph.D., Utah*
 Geoarchaeology; paleoenvironments; paleoecology; microstratigraphy; geochronology
Mark D. Feigenson, *Professor of Geological Sciences, FAS–NB; Ph.D., Princeton*
 Geochemistry of igneous rocks and other geologic samples
Claude T. Herzberg, *Professor of Geological Sciences, FAS–NB; Ph.D., Edinburgh*
 Solid and liquid silicate solutions; applications to planetary interiors
Gregory F. Herzog, *Professor of Chemistry, FAS–NB; Ph.D., Columbia*
 Meteoritics: radiometric dating and cosmic ray exposure; trace elements
Roger H. Hewins, *Professor of Geological Sciences, FAS–NB; Ph.D., Toronto*
 Petrology of meteorites, mafic and ultramafic rocks; mineral chemistry
Dennis V. Kent, *Professor of Geological Sciences, FAS–NB; Ph.D., Columbia*
 Paleomagnetics; paleogeography; stratigraphy
Richard A. Lutz, *Professor of Marine and Coastal Sciences, IMCS; Ph.D., Maine*
 Marine ecology and paleoecology; malacology; invertebrate paleontology; ecology of deep-sea hydrothermal vents
George R. McGhee, *Professor of Geological Sciences, FAS–NB; Ph.D., Rochester*
 Evolutionary theory; mass extinction; community paleoecology and evolution; functional and theoretical morphology; Paleozoic stratigraphy
Kenneth G. Miller, Sr., *Chair and Professor of Geological Sciences, FAS–NB; Ph.D., Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program in Oceanography*
 Late cretaceous to Cenozoic sea-level and paleoceanographic changes; integration of isotope, bio-, magneto-, and seismic stratigraphy
Gregory S. Mountain, *Professor of Geological Sciences, FAS–NB; Ph.D., Columbia*
 Seismic stratigraphy; paleoceanography; sea-level studies; continental margin evolution
Richard K. Olsson, *Professor Emeritus of Geological Sciences, FAS–NB; Ph.D., Princeton*
 Micropaleontology; stratigraphy; paleoecology; paleobathymetry of Cretaceous and Cenozoic formaminifera
David A. Robinson, *Professor of Geography, FAS–NB; Ph.D., Columbia*
 Climatology; cryosphere; solar radiation; physical geography
Peter A. Rona, *Professor of Geological Sciences and Marine and Coastal Sciences, FAS–NB/IMCS; Ph.D., Yale*
 Oceanic ridge crest processes; sea floor hydrothermal processes; marine geology and geophysics
Yair Rosenthal, *Associate Professor of Geological Sciences, FAS–NB; Ph.D., Massachusetts Institute of Technology/Woods Hole Oceanographic Institution*
 Geochemistry, paleoceanography, trace metal biogeochemistry, metal cycling in estuarine and coastal sediments
Roy W. Schlische, *Associate Professor of Geological Sciences, FAS–NB; Ph.D., Columbia*
 Extensional tectonics; structural and stratigraphic development of rift basins; growth of faults
Robert E. Sheridan, *Professor Emeritus of Geological Sciences, FAS–NB; Ph.D., Columbia*
 Seismic reflection and refraction; seismic stratigraphy; general geophysics; geology of the Atlantic continental margin

Robert M. Sherrell, *Associate Professor of Geological Sciences and Marine and*
Coastal Sciences, FAS–NB/IMCS; Ph.D., Massachusetts Institute of
Technology/Woods Hole Oceanographic Institution
Geochemistry of marine and fresh waters; paleochemical records in ice cores

Carl Swisher III, *Associate Professor of Geological Sciences, FAS–NB; Ph.D.,*
California (Berkeley)
Geochronology; vertebrate paleontology; human origins

Martha O. Withjack, *Professor of Geological Sciences, FAS–NB; Ph.D., Brown*
Experimental structural geology; seismic stratigraphy

James D. Wright, *Assistant Professor of Geological Sciences, FAS–NB;*
Ph.D., Columbia
Marine geology; paleoceanography; stable isotopes; stratigraphy

Associate Members of the Graduate Faculty

Lloyd Burckle, *Adjunct Professor of Geological Sciences, FAS–NB;*
Ph.D., New York
Micropaleontology (diatoms), paleoceanography, ice volume history

Colomban de Vargas, *Assistant Professor of Marine and Coastal Sciences,*
CC; Ph.D., Geneva
Molecular genetics of planktonic foraminifera and coccolithophores

Alexander E. Gates, *Associate Professor of Geology, FAS–N; Ph.D., Virginia*
Polytechnic Institute and State University
Tectonics; structural geology; deformational-chemical interactions
in orogenic belts

Michelle Goman, *Lecturer in Geological Sciences, FAS–NB; Ph.D.,*
California (Berkeley)
Coastal geomorphology; geoarchaeology; paleoecology

Michael J. Kennish, *Research Marine Scientist, IMCS; Ph.D., Rutgers*
Biology and geology of deep-sea hydrothermal vents; anthropogenic impacts on
coastal and estuarine waters

John R. Reinfelder, *Associate Professor of Environmental Sciences, CC; Ph.D.,*
SUNY (Stony Brook)
Metals in marine phytoplankton and coastal waters

Ying-Fan Reinfelder, *Lecturer in Geological Sciences, FAS–NB; Ph.D., Utah State*
Mathematical modeling of groundwater flow and its relationships to rocks and
sediments; weathering and erosional/depositional processes

Kathleen M. Scott, *Associate Professor of Biological Sciences, FAS–NB;*
Ph.D., Yale
Functional morphology; paleoecology of ungulates; mammalian evolution

Adjunct Members of the Graduate Faculty

William A. Berggren, *Distinguished Visiting Professor, FAS–NB;*
Ph.D., Stockholm
Taxonomy, biostratigraphy, paleobiogeography of Mesozoic and Cenozoic plank -
tonic and benthic foraminifera; global marine-continental stratigraphic correla -
tions and time scales; paleoceanography

Peter Sugarman, *Supervising Geologist, New Jersey Geological Survey;*
Ph.D., Rutgers
Sequence stratigraphy; hydrogeology

Brigitte M. Zanda, *Maître de Conférences des Universités II, Muséum National*
d'Histoire Naturelle, Paris; Ph.D., Paris
Meteoritics: chondrule formation, evolution and metamorphism; cosmic
ray exposure

Programs

Research activities of the program involve stratigraphy, sedimen-
tology, paleoceanography, paleomagnetics, paleontology, paleoecol-
ogy, biostratigraphy, structural geology, tectonics, geochemistry,
geophysics, volcanology, igneous petrology, and quaternary geol-
ogy. A broad background in chemistry, physics, mathematics,
and geology is stressed. The graduate committee sets a course of
study for each new student and encourages each one to outline a
research program in consultation with a faculty member. That
faculty member becomes the student's adviser.

A written thesis, 24 credits of course work, and 6 credits of
research are required for the master's degree. A minimum of
36 credits of course work out of a total 72 credits is required for
the doctorate. A candidate for the Ph.D. must demonstrate satisfac-
tory capability in computers. In addition, he or she must pass
a qualifying examination that includes a comprehensive written
examination and an oral defense of the proposed dissertation
research. One year of full-time graduate work satisfies the resi-
dency requirement. The master of philosophy degree is available
to doctoral candidates.

All applicants should submit three letters of recommendation
and their Graduate Record Examination results. Part-time students
are encouraged to apply.

Graduate Courses

16:460:501. (S) ECONOMIC GEOLOGY (3)
Feigenson. Prerequisite: 01:460:401 or 402 or equivalent.
Geochemistry of hydrothermal ore deposits, including studies
of alteration, ore mineral solubility, fluid inclusions, mass transfer,
and stable and radiogenic isotopes.

16:460:503. (F) STUDIES IN PALEONTOLOGY (3)
Prerequisite: 01:460:303 or equivalent.
Topics include methods and case studies in systematics, evolution
and extinction, paleogeography, paleoclimate, and other topics of
current interest. Emphasis on the relationship between geological
and biological processes.

16:460:505. (F) SEDIMENTARY GEOLOGY (3)
Prerequisite: 01:460:341.
Topics of current interdisciplinary research in sedimentary
geology. Sequence stratigraphy, facies models, sea-level change,
unconformities/hiatuses, tectonics, climate change, cyclicity, evolu-
tion, mass extinctions.

16:460:506. (S) STRUCTURE AND FORMATION OF THE EARTH (3)
Feigenson, Herzberg, Hewins. Prerequisites: 01:460:302, 307, 401, or permission
of instructor.
Topics of current research on the internal structure of the earth.
Mantle structure, phase changes, seismic discontinuities, trace-
element/isotopic properties, mineral physics, core formation,
meteorites, moons, asteroids.

16:460:507. (S) GEODYNAMICS (3)
Prerequisites: 01:460:307, 16:460:512.
Topics of current research in structural geology, geophysics, and
tectonics. Deformation of the crust and mantle; convection in the
mantle and core; the gravity and magnetic field of the earth; plate
tectonics and the origin of earthquakes and volcanoes.

16:460:508. (F) MINERAL PHASE RELATIONS (3)
Hewins. Prerequisite: 01:460:308.
Free-energy diagrams and phase diagrams, equilibrium and kinet -
ics, nucleation theory, undercooling, diffusion. Major groups of
rock-forming minerals; comparison of laboratory data and theoreti-
cal models with assemblages, compositions, and morphologies
actually observed in slowly cooled and rapidly cooled rocks.

16:460:509. (F) METEORITICS (3)
Hewins. Prerequisite: 01:460:302.
Petrology and geochemistry of meteorites, origin of solar system,
thermal history of asteroids.

16:460:511. (S) PETROLOGY (3)
Herzberg. Prerequisites: 01:460:301, 302, or equivalent.
Basic principles of thermodynamics applied to solid-solid and
solid-liquid equilibria in silicate systems; igneous and metamor-
phic processes that structured the petrology of the earth's crust
and mantle through time.

16:460:512. (S) METAMORPHIC PETROLOGY (3)
Herzberg. Prerequisites: 01:460:301, 302, or equivalent.
Principles of thermodynamics applied to the stabilities of mineral
assemblages in metaigneous and metasedimentary rocks of the
earth's crust; fluids in the crust; metamorphism and plate tectonics.

16:460:513. (S) VOLCANOLOGY (3)
Carr. Prerequisite: 01:460:302 or equivalent.
Geologic settings of volcanos; geophysical and geochemical con-
straints on the origin of magmas; energetics and periodicity; vol-
canos and earthquakes; eruption mechanisms; volcanic hazards
and prediction; geothermal power and volcanogenic ore deposits.

16:460:514. (S) DEPOSITIONAL ENVIRONMENTS (3)
Ashley. Prerequisite: 01:460:340 or equivalent.
Examination of classic depositional environments, with emphasis
on sedimentary processes. Sediment sampling and analyzing;
sedimentary structures; grain characteristics; facies models.

16:460:515. (F) Advanced Tectonics (3)
Withjack. Prerequisites: Structural geology, two terms of calculus.
Plate tectonic theory; quantitative analysis of plate motions on a sphere; use of paleomagnetism and seismology in tectonics; causes of plate motion.

16:460:516. (F) Advanced Structural Geology (3)
Schlische. Lec. 2 hrs., lab. 3 hrs. Prerequisites: Structural geology, two terms of calculus, linear algebra.
Advanced topics in structural geology, including tensor analysis of stress and strain; practical strain measurement; geometric, kinematic, and dynamic analysis of folds and fractures; seismic expression of structural styles.

16:460:519. (F) Mesozoic-Cenozoic Stratigraphy (3)
Miller. Prerequisite: 01:460:304.
Study of the Mesozoic-Cenozoic stratigraphic sequences in different basinal settings and relationship to tectonic history.

16:460:525. (S) Marine Sedimentology (3)
Ashley. Prerequisite: 01:460:340 or equivalent.
Examination of the physical processes of sedimentation on the continental shelf and continental slope environments. Interrelationship between organisms and sediment, as well as environmental problems.

16:460:526. (F) Paleoceanography (3)
Miller, Rosenthal, Wright. Prerequisite: Paleontology.
Paleoecology, paleoclimatology, and paleogeography of marine microfossils; study of major paleoceanographic events and their relationships to stratigraphy and sedimentary facies.

16:460:528. (F) Groundwater Modeling (3)
Reinfelder. Prerequisite: 01:460:428 or equivalent.
Modeling of groundwater flow and associated mass/energy transport. Real examples used to formulate correct mathematical statement of problem; numerical models applied for solution.

16:460:538. (S) Evolutionary Paleoecology (3)
McGhee. Prerequisite: 01:460:303 or equivalent.
Evolution of ecological systems in geologic time; application of evolutionary theory to paleoecological patterns and processes.

16:460:541. (F) Marine Geology (3)
Miller, Wright. Prerequisite: 01:460:341 or equivalent or permission of instructor.
Structure and evolution of ocean basins, continental margins, and marine sediments.

16:460:551. (S) Isotope Geochemistry (3)
Feigenson. Prerequisite: 01:460:401 or equivalent.
Studies of stable and radiogenic isotopes in the earth's mantle and crust. The use of isotopes in age dating, source tracing, and geothermometry.

16:460:553 (F) Paleomagnetism (3)
Kent. Prerequisite: 01:460:412 or equivalent.
Applications of geomagnetism and paleomagnetic techniques to geological and geophysical problems. Topics include the modern geomagnetic field, secular variation, the earth dynamo, rock magnetism, paleomagnetic studies, geomagnetic reversals, magnetostratigraphy, paleointensity variations, apparent and true polar wander, environmental magnetism, and magnetic proxies of climate change.

16:460:555. (F) Geophysics I (3)
Sheridan. Prerequisites: 01:460:307, 01:640:252, 01:750:204, or permission of instructor.
Theory and application of seismic refraction, seismic reflection, deep-earth seismology, surface waves, and heat flow. Collection and interpretation of seismic data.

16:460:556. (S) Geophysics II (3)
Sheridan. Prerequisites: 01:460:307, 01:640:252, 01:750:204, or permission of instructor.
Theory and application of gravity, magnetics, paleomagnetics, and electrical prospecting. Measurement and interpretation of potential field anomalies.

16:460:560. (S) Numerical Methods in Paleoecology (3)
McGhee. Prerequisites: Calculus and statistics, or permission of instructor.
Digital computational methods for paleoecologists and paleontologists; measurement systems and data transformation; statistics; discrete association and gradient analytic techniques for paleoecological research. Emphasis on applied data analysis.

16:460:561. (F) Studies in Micropaleontology (3)
Prerequisites: 01:460:303, 341.
Paleoecology and biostratigraphy of foraminifera; identification and interpretation of microscopic organic remains in rocks and sediments.

16:460:601,602. Advanced Studies in Geology (BA,BA)

16:460:611. Seminar in Geology (BA)
Course may be taken more than once.
Special topics chosen each term.

116:460:612. (F) Graduate Research Seminar (1)
Presentation and discussion of current topics in geosciences, and faculty- and student-led group discussions on topics of professional development (some examples: paper authorship, reviewing papers and proposals, writing proposals, ethics and scientific fraud, funding, news about science).

16:460:655,656. (F,S) Research Colloquium (1,1)
Students attend weekly lectures by visiting scientists on current research in geosciences; one or more papers required on one or more of the topics covered.

16:460:701,702. Research in Geology (BA,BA)

GEOSPATIAL INFORMATION SCIENCE 455

Program Offered: **Certificate Program in Geospatial Information Science**
Director of the Certificate Program in Geospatial Information Science: **Professor Richard G. Lathrop, Department of Ecology, Evolution, and Natural Resources, 14 College Farm Road, Cook Campus (732/932-1580)**
Email: *lathrop@crssa.rutgers.edu*

Participating Faculty
R. Brail, *Urban Planning and Policy Development*
C. Hatfield, *Ecology and Evolution*
R. Lathrop, *Ecology and Evolution*
K. St. Martin, *Geography*
D. Tulloch, *Geography*
L. Wiggins, *Urban Planning and Policy Development*
M. Xu, *Ecology and Evolution*

Certificate Program

Three competing foci define research in geospatial information science. One strand of research addresses the fundamental questions of the human conceptualization of space and how geospatial information (i.e., information that can be tied to a particular location on the earth's surface) is generated, located, recorded, modeled, manipulated, and/or communicated through computer technology. A second strand of research addresses how geospatial information science and technology can be applied to real world problems across a variety of physical, environmental, and social science disciplines. A third strand of research investigates the societal implications of GIS technology on social interactions on a variety of levels, e.g., people to the environment, people-to-people, and people-to-government. The certificate program is designed to

introduce students to these three strands of research, as well as provide the students hands-on training in the technology so that they may apply it in their disciplinary areas of research. To receive the certificate, students must complete, in addition to the requirements in their major program, the prerequisites and the basic and advanced topics courses listed below. Also, the student must complete a 3-credit seminar in geospatial information science that will serve as a capstone course.

Prerequisites

Proficiency in computer programming (e.g., one language: C, VisualBasic, etc.), introductory cartography, geographic information systems, and basic statistics. If this proficiency is lacking, then the appropriate undergraduate courses should be taken:

01:198:111	Introduction to Computer Science (3)	
01:450:321	Geographic Information Systems (3)	
01:450:355	Principles of Cartography (4)	
01:960:401	Basic Statistics for Research (or equivalent) (3)	
11:372:362	Intermediate Environmental Geomatics (3)	

Basic Topics in Geospatial Information Science (6)

One course each in geographic information systems and remote sensing as prerequisite for the certificate seminar:

GIS

34:970:592. Topics in Geographic Information Science (3)

Remote Sensing/Digital Image Processing

16:450:535. Advanced Remote Sensing (3)

Certificate Seminar (3)

16:___:501. Seminar in Geospatial Information Science (3)

Three competing foci define research in geospatial information science: (1) human conceptualization of space as it relates to geospatial information, (2) application of geospatial information science and technology, and (3) societal implications of GIS technology.

Advanced Topics in Geospatial Information Science (3)

One course from the list below:

16:194:601	Information and Communication Processes (3)
16:198:535	Pattern Recognition Theory and Applications (3)
16:198:541	Database Systems (3)
16:332:560	Computer Graphics (3)
16:375:551	Remote Sensing of the Ocean and Atmosphere (3)
16:450:617	Seminar in Remote Sensing of the Biosphere (3)
16:712:615	Geophysical Data Analysis (3)
17:610:557	Database Design and Management (3)
22:198:603	Database Systems (3)

Alternative courses can be substituted with permission of the certificate director.

GERMAN 470

Degree Programs Offered: Master of Arts, Master of Arts for Teachers, Doctor of Philosophy

Director of Graduate Program: Professor William Collins Donahue, 101-AGerman House, 64 College Avenue, College Avenue Campus (732/932-7201/7379)

Members of the Graduate Faculty

Stephen Bronner, *Professor of Political Science, FAS–NB; Ph.D., California (Berkeley)*
Politics and culture; philosophical idealism; modern political history; critical theory
Marlene Ciklamini, *Professor of German, FAS–NB; Ph.D., Yale*
History of the German language; Old Norse literature; medieval studies

Christine Cosentino-Dougherty, *Professor of German, FAS–C; Ph.D., Columbia*
Literature before and after German unification; expressionism
Belinda Davis, *Associate Professor of History, FAS–NB; Ph.D., Michigan*
Twentieth-century German and Europe; history of New Left activism; women's history
William Collins Donahue, *Assistant Professor of German, FAS–NB; Ph.D., Harvard*
Nineteenth- and 20th-century literature; German-Jewish studies
Paul Hanebrink, *Assistant Professor of History, FAS–NB; Ph.D., Chicago*
Modern East Central Europe; the history of nationalism and anti-Semitism as modern political ideologies; religion in the modern nation-state
Hildburg Herbst, *Associate Professor of German, FAS–NB; Ph.D., Princeton*
Eighteenth-century romanticism; German literature; German cinema
Fatima Naqvi, *Assistant Professor of German, FAS–NB; Ph.D., Harvard*
Twentieth-century German and Austrian literature, culture, and film (post 1945)
Joanna M. Ratych, *Professor Emerita of German; FAS–NB; Ph.D., Munich*
Contemporary German literature; stylistics
Nicholas A. Rennie, *Assistant Professor of German, FAS–NB; Ph.D., Yale*
Eighteenth- to 20th-century aesthetics; theory
James A. Rushing, *Associate Professor of German, FAS–C; Ph.D., Princeton*
Medieval studies, 19th- and 20th-century narrative
Jeffrey Shandler, *Assistant Professor of Jewish Studies, FAS–NB; Ph.D., Columbia*
Yiddish language, literature, and culture; Holocaust representation; Jews and media
Otto J. Zitzelsberger, *Professor of German, FAS–N; Ph.D., Columbia*
German philology and literature prior to 1500

Programs

Areas of specialization available include philology, older German literature before the baroque period, and German literature of the 17th, 18th, 19th, or 20th century. Requirements for the master's degree are 30 credits of course work beyond the bachelor's degree (or 24 credits and a thesis) and an examination covering the general field of German literature. In addition, students must display knowledge of the history of the German language and of Middle-High German.

Students pursuing the doctorate must take a minimum of 48 credits of course work beyond the bachelor's degree and possess a reading knowledge of one additional language, as deemed appropriate by the candidates' advisers. In addition, a candidate must complete successfully a written examination based on a core reading list and an oral examination in his or her area of specialization. Finally, each candidate must submit an acceptable dissertation. The Ph.D. qualifying examination may be taken in parts spaced over six months. No more than 3 credits for the master's degree and no more than 6 credits for the doctorate may be taken in independent study courses. A master of philosophy degree can be obtained by candidates who complete their course work and qualifying examination within four years. Although there is no formal residence requirement, the candidates accepted must be available for close supervision and consultation.

Courses at the 500 and 600 levels are open to all graduate students and constitute the major portion of the program. As part of their graduate training, doctoral students are given the opportunity to assume certain teaching obligations under faculty supervision. Further details concerning the program, including additional information about the qualifying examination and the dissertation, as well as information about teaching assistantships, can be found in *Graduate Programs in German* and in *Guidelines for Graduate Students in German.* These pamphlets are available on request from the office of the graduate director. The graduate program in German participates in the Transliteratures program (q.u.).

Graduate Courses

Three courses from the following list normally are offered each term.

16:470:501. The Teaching of College German (3)
Introduction to the nature of language acquisition; critical examination of instructional materials; principles of cultural analysis; theory and practice of teaching literature. Patterned to the practice of college instruction.

16:470:502. TEACHING APPRENTICESHIP IN GERMAN (N1.5)
Weekly workshops for teaching, testing, and evaluation techniques in elementary and intermediate language courses. Observation of language classes.

16:470:510. LITERARY THEORY AND METHODOLOGY (3)
Ciklamini, Rennie, Rushing. Recommended during the first year.
Study and practice of scholarly techniques, the use of secondary literature for research, the writing of papers, and an overview of literary theories.

16:470:511. ADVANCED GRAMMAR (3)
Ciklamini
Comparison of syntactic and semantic differences between source and target languages.

16:470:512. ADVANCED STYLISTICS (3)
Studies in the nature and development of literary styles and nonfiction prose from the 16th century to the present, with emphasis on the expressive possibilities of various syntactic modes.

16:470:513. ANALYSIS OF LITERARY TEXTS (3)
Study of selected works of poetry, drama, and prose with a view to increasing a teacher's faculties of literary interpretation and aesthetic judgment.

16:470:515. HISTORY OF THE GERMAN LANGUAGE (3)
Ciklamini, Zitzelsberger
Survey of linguistic changes and phenomena from the Indo-European era to the present.

16:470:516. INTRODUCTION TO MIDDLE-HIGH GERMAN (3)
Ciklamini, Zitzelsberger
Phonology and grammar. Reading of representative texts from the Middle-High German period A.D. 1050 to A.D. 1350, with special emphasis on the popular epic, court epic, and Minnesänger.

16:470:517. INTRODUCTION TO OLD HIGH GERMAN (3)
Zitzelsberger
Survey of the morphology of Old High German with readings and discussions of representative literary texts as recorded in the various dialects.

16:470:520. LITERATURE OF THE MIDDLE AGES (3)
Ciklamini, Zitzelsberger
Analysis of the folk epic *(Nibelungenlied)* and its sources; the courtly romances by Hartmann von Aue, Wolfram von Eschenbach, and Gottfried von Strassburg; the saint's legend; and poems by prominent Minnesänger.

16:470:521. LITERATURE OF THE RENAISSANCE, REFORMATION, AND BAROQUE (3)
Zitzelsberger
Sociohistorical overview of German literature of the 16th and 17th centuries.

16:470:522. FROM ROCOCO TO CLASSICISM (3)
Herbst, Rennie
Literature of the 18th century with emphasis on *Anakreontik, Sturm und Drang*, and the *Weimarer Klassik*, focusing mainly on contemporaries of Goethe and Schiller.

16:470:523. GERMAN ROMANTICISM (3)
Ciklamini, Herbst
Aims and characteristics of the romantic movement as reflected in the works of Hölderlin, Novalis, Kleist, Brentano, Eichendorff, and Hoffmann.

16:470:524. NINETEENTH-CENTURY REALISM (3)
Donahue, Rushing
Studies in the theory, themes, and styles of German literary realism in the 19th century, focusing on the works by Büchner, Hebbel, Stifter, Keller, Meyer, Storm, and Fontane.

16:470:525. LITERATURE OF THE 20TH CENTURY BEFORE 1945 (3)
Donahue, Naqvi
Study of significant literary works and trends against the background of late Wilhelminian Germany, the Weimar Republic, and the Nazi era.

16:470:526. LITERATURE OF THE 20TH CENTURY AFTER 1945 (3)
Consentino-Dougherty, Donahue, Naqvi
Study of German writers after World War II, including Bernhard, Borchert, Böll, Dürrenmatt, Frisch, Grass, Handke, Hochhuth, Johnson, Lenz, Botho Strauss, Walser, and Weiss.

16:470:601,602. INDEPENDENT STUDY IN GERMANIC LANGUAGES AND LITERATURES (3,3)
Prerequisites: Permission of instructor and approval of graduate director.
Independent study or directed research. Intended for exploring areas not covered in depth by regularly scheduled courses.

16:470:610. OLD NORSE LITERATURE (3)
Ciklamini, Zitzelsberger. Conducted in English.
Principal genres of saga literature; Eddic and Scaldic poetry.

16:470:611. COURTLY POETRY AND MEDIEVAL DRAMA (3)
Ciklamini, Rushing, Zitzelsberger
Major lyrics of the *Minnesang* and its later developments. The Latin and romance origins of German lyric poetry. Selected dramas from the 13th to the late 15th centuries.

16:470:615. LITERATURE OF THE BAROQUE (3)
Zitzelsberger
Study of lyric, dramatic, and prose works as an expression of religious, historical, and cultural currents of the 17th century.

16:470:622. THE GERMAN ENLIGHTENMENT (3)
Herbst, Rennie
The concept and question of German Enlightenment, especially as it relates to modernity. Readings by Leibniz, Kant, Mendelssohn, Gottsched, Bodmer, Lessing, Klopstock, Wieland, and Gellert.

16:470:625. GOETHE (3)
Herbst, Rennie
Study of Goethe's poetry, drama, and prose, focusing on three major areas: works of the Storm and Stress, works of Goethe's classical period, and the "Alterswerk," including *Faust.*

16:470:626. FAUST IN GERMAN LITERATURE (3)
Herbst
The Faust tradition from biblical days to contemporary German literature. Emphasis on the *Volksbuch,* the Faust theme in the Storm and Stress period, Goethe's *Faust,* and Faust works of the 20th century.

16:470:627. SCHILLER (3)
Herbst
Schiller's development as an author through detailed study of his prose, poetry, and plays, including *Die Räuber, Kabale und Liebe, Don Carlos,* and *Wallenstein.*

16:470:632. HEINE AND HIS CONTEMPORARIES (3)
Development of German literature of the 19th century in the context of social and political change brought about by the end of feudalism and the rise of industrialism in the period 1813 to 1849.

16:470:642. THE EXPRESSIONIST MOVEMENT (3)
Cosentino-Dougherty
German expressionism from its early prewar phase to the mid-1920s, with emphasis on its philosophical foundations, sociopolitical aims, and poetic styles. The poets Benn, Heym, Stadler, Stramm, and Werfel; the dramatists Goering, Hasenclever, Kaiser, Sorge, Sternheim, and Toller.

16:470:645. CONTEMPORARY GERMANY (3)
Cosentino-Dougherty, Donahue, Naqvi
Study of modern Germany with consideration of pertinent cultural, historical, political, geographical, and sociological factors and their impact on contemporary literary life.

16:470:650. LYRICAL POETRY FROM THE MIDDLE AGES TO THE PRESENT (3)
Ratych
Study of significant poets, with special emphasis on the development of literary movements and the intellectual background of the times.

16:470:651. GERMAN DRAMA FROM THE BAROQUE TO THE PRESENT (3)
Ratych
Readings of selected plays with background studies in the theory and historical development of the drama.

16:470:652. SHORT FORMS OF GERMAN PROSE (3)
Donahue, Herbst, Naqvi
Short prose forms such as the Anekdote, Skizze, Novelle, Erzählung, and Kurzgeschichte. Historical, theoretical, and analytical approaches to representative works.

16:470:653. THE GERMAN "NOVELLE" AND "NOVELLE" THEORY (3)
Donahue, Herbst
Development of the *Novelle* as a specific German narrative form and as an expression of social, philosophical, and metaphysical viewpoints.

16:470:654. THE GERMAN NOVEL (3)
Donahue, Rennie
Development of the novel as a literary genre in German literature. Emphasis on European influences, the novel and the court, the rise of the bourgeoisie, women and writing, and theory of novel.

16:470:660. AUSTRIAN NARRATIVE OF THE 19TH AND 20TH CENTURIES (3)
Naqvi, Rennie
Comparative study of representative works that use various narrative techniques. Special emphasis on the end of the monarchy, the emergence of national socialism, and the period after 1945.

16:470:661. FOLKLORE IN GERMAN LITERATURE (3)
Ciklamini
Archetypal patterns, motifs, figures in folklore, *Sage*, folksong, hagiography, and sources in pagan and biblical tradition as a basis for study of adaptations and interpretations in literary works of various genres and periods to the present.

16:470:662. GERMAN FEMINIST WRITERS (3)
Donahue, Naqvi
The rise of literary feminism and a sociological analysis of women's literature.

16:470:663. LITERATURE AND IDEOLOGY (3)
Donahue, Rennie, Rushing
Study in the history of ideas, dealing specifically with the conflict of ideologies in varying periods of German culture as expressed in the works of such authors as Gottfried von Strassburg, Luther, Gryphius, Goethe, Büchner, Nietzsche, Wagner, and Brecht.

16:470:670,671,672,673. TOPICS IN GERMAN LITERATURE I,II,III,IV (3,3,3,3)
Special topics devoted to the investigation of a single author, text, critical or philosophical problem, theme or motif, historical period or development.

16:470:701,702. RESEARCH IN GERMAN (BA,BA)

Interdisciplinary Graduate Course

15:617:510. INTRODUCTION TO LITERARY THEORY (3)
Davidson, Edmunds, Eisenzweig, Flieger, Galperin, Marsh, Persin. Open to second-term graduate students; priority given to students from programs participating in the Council of Languages and Literature.
Introduction to contemporary literary theory, including formalism, structuralism, poststructuralism, feminism, psychoanalysis, cultural studies, and other approaches. Readings of theoretical texts and applications to short literary texts from a variety of literatures.

HISTORY 510

Degree Programs Offered: **Master of Arts, Doctor of Philosophy**
Director of Graduate Program: **Professor Ziva Galili,**
  305D Van Dyck Hall, College Avenue Campus (732/932-8493)
Vice Chairperson for Graduate Education: **Professor Alastair Bellany,**
  305E Van Dyck Hall, College Avenue Campus (732/932-7941)

Members of the Graduate Faculty

Michael P. Adas, *Abraham Voorhees Professor of History, FAS–NB; Ph.D., Wisconsin*
  Comparative history; colonialism and technology
Juliana Barr, *Assistant Professor of History, FAS–NB; Ph.D., Wisconsin (Madison)*
  Colonial, Native American, and women's history
Norma Basch, *Professor of History, FAS–N; Ph.D., New York*
  American legal history; U.S. antebellum politics and culture
Mia Elisabeth Bay, *Associate Professor of History, FAS–NB; Ph.D., Yale*
  African-American history; American intellectual and cultural history
Rudolph M. Bell, *Professor of History, FAS–NB; Ph.D., CUNY*
  Europe; quantitative history
Alastair Bellany, *Associate Professor of History, FAS–NB; Ph.D., Princeton*
  Early modern Britain
Herman L. Bennett, *Associate Professor of History, FAS–NB; Ph.D., Duke*
  Colonial Latin American history; early modern Iberian history
Lauren Benton, *Associate Professor of History, FAS–N/NJIT; Ph.D., Johns Hopkins*
  Comparative economic development; world history; Latin America and Spain; anthropology
Carolyn Brown, *Associate Professor of History, FAS–NB; Ph.D., Columbia*
  African history; labor history
Christopher L. Brown, *Assistant Professor of History, FAS–NB; D.Phil., Oxford*
  Early America; Afro-American history; comparative history
Kim D. Butler, *Assistant Professor of History, FAS–NB; Ph.D., Johns Hopkins*
  Brazilian studies; African diaspora history; Afro-Latin and Afro-Caribbean studies
Jack L. Cargill, *Professor of History, FAS–NB; Ph.D., California (Berkeley)*
  Ancient Greek history and epigraphy; ancient Rome
John W. Chambers, *Professor of History, FAS–NB; Ph.D., Columbia*
  Twentieth-century U.S. history: especially war and peace studies, film and history, political history, U.S. foreign relations
Indrani Chatterjee, *Associate Professor of History, FAS–NB; Ph.D., London*
  South Asia; slavery; gender; social history
Paul G.E. Clemens, *Professor of History, FAS–NB; Ph.D., Wisconsin*
  Early American history and history of the South
Dorothy Sue Cobble, *Associate Professor of History, FAS–NB; Ph.D., Stanford*
  Labor and women's history
Barbara Cooper, *Associate Professor of History and African Studies, FAS–NB; Ph.D., Boston*
  African history, gender and culture
Susan Lisa Curruthers, *Associate Professor of History, FAS–NB; Ph.D., Leeds*
  U.S. foreign relations; media and war; culture and cold war; empire
Belinda Davis, *Associate Professor of History, FAS–NB; Ph.D., Michigan (Ann Arbor)*
  Modern European history; Germany; women's history
Ann F. Fabian, *Associate Professor of American Studies and History, FAS–NB; Ph.D., Yale*
  American cultural and intellectual history
Leslie Ellen Fishbein, *Associate Professor of American Studies, FAS–NB; Ph.D., Harvard*
  Women's history
Robert L. Fishman, *Professor of History, FAS–C; Ph.D., Harvard*
  Urban history
David Foglesong, *Associate Professor of History, FAS–NB; Ph.D., California (Berkeley)*
  History of American foreign relations
Ziva Galili, *Professor of History, FAS–NB; Ph.D., Columbia*
  Social, economic, political history of modern Russia; Eastern Europe

Lloyd C. Gardner, *Charles and Mary Beard Professor Emeritus of History, FAS–NB; Ph.D., Wisconsin*
American diplomatic history

Lora D. Garrison, *Professor of History, FAS–NB; Ph.D., California (Irvine)*
Women and reform movements; recent United States history

Michael N. Geselowitz, *Director, IEEE History Center, FAS–NB; Ph.D., Harvard*
History of technology and science

Angus Kress Gillespie, *Professor of American Studies, FAS–NB; Ph.D., Pennsylvania*
American folklore

Howard Gillette, *Professor of History, FAS–C; Ph.D., Yale*
U.S. urban history; urban policy

William Gillette, *Professor of History, FAS–NB; Ph.D., Princeton*
Civil war and reconstruction

John R. Gillis, *Professor of History, FAS–NB; Ph.D., Stanford*
Modern European social history and British history

Janet Golden, *Associate Professor of History, FAS–C; Ph.D., Boston*
U.S. women's history; U.S. social history; history of medicine

Peter B. Golden, *Professor of History, FAS–N; Ph.D., Columbia*
Medieval Eurasia

James Goodman, *Professor of History, FAS–N; Ph.D., Princeton*
Modern U.S. race relations and politics; literature as history

Ann D. Gordon, *Associate Research Professor, FAS–NB; Ph.D., Wisconsin (Madison)*
Papers of Elizabeth Cady Stanton and Susan B. Anthony

Paul Hanebrink, *Assistant Professor of History, FAS–NB; Ph.D., Chicago*
Twentieth-century eastern Europe, the Habsburg Empire, 20th-century Europe

Mary S. Hartman, *University Professor of History, FAS–NB; Ph.D., Columbia*
Nineteenth-century France; women's history

Joseph Held, *Associate Professor of History, FAS–C; Ph.D., Rutgers*
Eastern Europe

Jochen Hellbeck, *Assistant Professor of History, FAS–NB; Ph.D., Columbia*
Soviet Union

Lisa Herschbach, *Assistant Professor of History, NJIT/FAS–N; Ph.D., Harvard*
History of medicine, science, and technology

Nancy Hewitt, *Professor of History, FAS–NB; Ph.D., Pennsylvania*
American women; 19th-century U.S. and comparative women

Allen M. Howard, *Associate Professor of History, FAS–NB; Ph.D., Wisconsin*
African history; world history

Alison Isenberg, *Assistant Professor of History, FAS–NB; Ph.D., Pennsylvania*
American urban, business culture

Paul B. Israel, *Managing Editor, Thomas A. Edison Papers, FAS–NB; Ph.D., Rutgers*
History of technology

Reese V. Jenkins, *Professor of History, FAS–NB; Ph.D., Wisconsin*
Modern science and technology

Jennifer M. Jones, *Associate Professor of History, FAS–NB; Ph.D., Princeton*
Early modern European; France, old regime and revolution; European women's history

Benjamin Justice, *Assistant Professor of Education, FAS–NB; Ph.D., Stanford*
History of education; prison education; religion in public schools; 19th-century United States

Temma Kaplan, *Professor of History, FAS–NB; Ph.D., Harvard*
Comparative women's history; history of Latin America; Spanish history

Donald R. Kelley, *James Westfall Thompson Professor of History, FAS–NB; Ph.D., Columbia*
European history

Samantha Kelly, *Assistant Professor of History, FAS–NB; Ph.D., Northwestern*
Medieval Europe

Steven Lawson, *Professor of History, FAS–NB; Ph.D., Columbia*
Twentieth-century United States; post–1945 United States; civil rights movement

T.J. Jackson Lears, *Board of Governors Professor of History, FAS–NB; Ph.D., Yale*
American cultural and intellectual history

Suzanne Lebsock, *Professor of History, FAS–NB; Ph.D., Virginia*
History of women, U.S. social history, history of the south

Dina LeGall, *Assistant Professor of History, FAS–NB; Ph.D., Princeton*
Ottoman history; modern Middle Eastern history

Jan E. Lewis, *Professor of History, FAS–N; Ph.D., Michigan*
U.S. family and women's history; early American history

Xun Liu, *Assistant Professor of History, FAS–NB; Ph.D., Southern California*
Modern China, traditional China, Daoism, history of Chinese medicine, modern East Asia

James Livingston, *Professor of History, FAS–NB; Ph.D., Northern Illinois*
Nineteenth- and 20th-century American intellectual and economic history

Julie Livingston, *Assistant Professor of History, FAS–NB; Ph.D., Emory*
African history, history of medicine

Jonathan Lurie, *Professor of History, FAS–N; Ph.D., Wisconsin*
Legal history

Phyllis Mack, *Professor of History, FAS–NB; Ph.D., Cornell*
Early modern European history; women's history; history of religion

Neil Maher, *Assistant Professor of History, FAS–C; Ph.D., New York*
American environmental history; history of technology; medicine and health; 20th century, U.S. social, and political history

Norman D. Markowitz, *Associate Professor of History, FAS–NB; Ph.D., Michigan*
American political and radical movements

Margaret Marsh, *Professor of History and Dean of the Faculty of Arts and Sciences–Camden and the Graduate School–Camden, FAS–C; Ph.D., Rutgers*
Gender and medicine; gender and culture; sexuality and reproduction

Luis Martínez-Fernández, *Associate Professor of History, FAS–NB; Ph.D., Duke*
Latin American history; Puerto Rican and Hispanic Caribbean studies

James P. Masschaele, *Associate Professor of History, FAS–NB; Ph.D., Toronto*
Medieval history; English economic history

Matt Matsuda, *Associate Professor of History, FAS–NB; Ph.D., California (Los Angeles)*
Modern European history; France; cultural history

Jennifer L. Morgan, *Assistant Professor of History, FAS–NB; Ph.D., Duke*
Early American history; African-American history; women's history

Karl F. Morrison, *Lessing Professor of History and Poetics, FAS–NB; Ph.D., Cornell*
Humanist tradition in western Europe, chiefly aesthetics and hermeneutics, in the Middle Ages

David L. Morton, Jr., *Adjunct Professor of History, FAS–NB; Ph.D., Georgia Institute of Technology*
History of technology

Frederik Nebeker, *Senior Research Historian, IEEE History Center, FAS–NB; Ph.D., Princeton*
History of technology

William L. O'Neill, *Professor of History, FAS–NB; Ph.D., California (Berkeley)*
Twentieth-century U.S. history

Philip J. Pauly, *Professor of History, FAS–NB; Ph.D., Johns Hopkins*
History of science

Clement Alexander Price, *Professor of History, FAS–N; Ph.D., Rutgers*
Afro-American history and culture; U.S. urban and social history

James W. Reed, *Professor of History, FAS–NB; Ph.D., Harvard*
U.S. social and intellectual history

Stephen W. Reinert, *Associate Professor of History, FAS–NB; Ph.D., California (Los Angeles)*
Byzantine, medieval Balkan, early Ottoman history

Michael Aaron Rockland, *Professor and Chair of American Studies, FAS–NB; Ph.D., Minnesota*
American popular culture

Donald T. Roden, *Associate Professor of History, FAS–NB; Ph.D., Wisconsin*
Modern Japanese social and intellectual history

Said S. Samatar, *Professor of History, FAS–N; Ph.D., Northwestern*
Somali; modern Africa; African nationalism; African literature and religion

Beryl E. Satter, *Professor of History, FAS–N; Ph.D., Yale*
U.S. women; American medicine

Susan R. Schrepfer, *Associate Professor of History, FAS–NB; Ph.D., California (Riverside)*
American social and environmental history

Joan W. Scott, *Professor of Social Science, Institute for Advanced Study; Ph.D., Wisconsin*
Feminist history and theory

Philip B. Scranton, *Board of Governors Professor of History, FAS–C; Ph.D., Pennsylvania*
American economic history; history of business and technology

Richard Sher, *Professor of History, NJIT/FAS–N; Ph.D., Chicago*
Social history of communications, technology, and enlightenment

Nancy Sinkoff, *Assistant Professor of History, FAS–NB; Ph.D., Columbia*
Early modern and modern Jewish history; Eastern European history

Bonnie G. Smith, *Professor of History, FAS–NB; Ph.D., Rochester*
Modern European history; women's history

Gail Triner-Besosa, *Associate Professor of History, FAS–NB; Ph.D., Columbia*
Latin America; Brazil

Gabor Vermes, *Associate Professor of History, FAS–N; Ph.D., Stanford*
The Hungarian revolution of 1918–1919; modern Hungary

Keith Wailoo, *Professor of History, FAS–NB; Ph.D., Pennsylvania*
History of medicine and history of science; U.S. cultural and intellectual history; African-American history

Mark Wasserman, *Professor of History, FAS–NB; Ph.D., Chicago*
Modern Latin American history; history of Mexico

Carmen T. Whalen, *Assistant Professor of Puerto Rican and Hispanic Caribbean Studies, FAS–NB; Ph.D., Rutgers*
U.S. immigration; women's history

Deborah G. White, *Professor of History, FAS–NB; Ph.D., Illinois*
Afro-American history; women's history

Virginia Yans-McLaughlin, *Professor of History, FAS–NB; Ph.D., SUNY (Buffalo)*
U.S. cultural history; women's history; history of immigration

Yael Zerubavel, *Professor of History, FAS–NB, and Director of the Center for the Study of Jewish Life; Ph.D., Pennsylvania*
Jewish social, cultural, intellectual, and literary history

Associate Members of the Graduate Faculty

Henry W. Bowden, *Professor of Religion, FAS–NB; Ph.D., Princeton*
American religious history

James Jones, *Associate Professor of Religion, FAS–NB; Ph.D., Brown*
U.S. religions

Programs

The graduate program in history is intended primarily for students who pursue full-time work toward a Ph.D. Requirements for a Ph.D. degree include 12 courses in history or in a supporting discipline. Two of those courses must be in a minor field, and two or more courses must be research seminars. Students must complete successfully examinations in their major and minor fields. Normally, these tests are taken in the third year. Doctoral candidates working in European and non-Western history must have a reading knowledge of two foreign languages. Candidates are required to prepare an acceptable thesis based on original research and defend that thesis successfully in a final examination conducted by a faculty committee. Credits for M.A. work in history done at other institutions likely will be transferred with the permission of the Graduate School–New Brunswick.

The M.A. is offered within the framework of the doctoral program. Its requirements include eight courses in history and successful completion of an examination in the student's major field. A thesis is not required. Students whose sole objective is the M.A. should consider applying to the M.A. program in American history on the Rutgers–Camden campus or to the M.A. program in history on the Rutgers–Newark campus. For further information about these M.A. programs, write to Department of History, Rutgers, The State University of New Jersey, Camden, NJ 08102; or Department of History, Rutgers, The State University of New Jersey, Newark, NJ 07102, respectively.

Students who plan to seek financial assistance should apply for the September term no later that January 15. Other students should apply by February 15. Transcripts, Graduate Record Examination scores, three letters of recommendation, and a writing sample are required.

The Ph.D. program offers work in most fields of American, European, Latin American, and East Asian history, but the department has particular strengths in early American, women's, cultural/intellectual, comparative/world, and African-American history. New major fields have been established in the history of technology, environment, and health; women's and gender history; the history of Atlantic cultures; and the African diaspora. Each is designed as an interdisciplinary curriculum. The department also is home to the Thomas A. Edison Papers, the Institute of Electronic and Electrical Engineers History Center, the Medieval and Early Modern Data Bank project, the Elizabeth Cady Stanton and Susan B. Anthony papers, and the African Studies Association.

A full description of the program may be found in the brochure *Graduate Study in History,* available from the department or online at *http://history.rutgers.edu.* This brochure also offers information about fellowships (which pay $13,000, plus tuition remission), teaching assistantships, and other forms of financial aid.

Graduate Courses

Courses in Historiography, Theory, and Practice

16:510:501. COLLOQUIUM: HISTORY OF HISTORICAL WRITING (3)
Kelley, Morrison, Reinert
Exploration of the evolution of historical writing in varying cultural and chronological contexts, but excluding contemporary historiographic theory and practice.

16:510:503. CONTEMPORARY HISTORIOGRAPHY—THEORY AND PRACTICE (3)
Lears, Livingston, Yans-McLaughlin
Impact of social and literary theories on the work of recent prominent historians, including assessments of the utility and testability of such theories in contemporary historical practice.

16:510:505. STATISTICAL METHODS IN HISTORY (3)
Bell
Analysis of secondary literature employing quantitative methods, design, implementation, and presentation of an original historical research problem involving statistical techniques and computer applications.

16:510:507. HISTORICAL EDITING (3)
Jenkins

16:510:509. TEACHING OF HISTORY (3)
Adas, Bell, Howard
Designed for second- or third-year students, including first-time teaching assistants. Offers guidance and practical experience in undergraduate instruction.

Courses with Transnational, Comparative, or Interdisciplinary Themes

16:510:511. COLLOQUIUM IN COMPARATIVE HISTORY (3)
Adas, Bennett, Howard

16:510:513. COLLOQUIUM IN CULTURAL HISTORY (3)
Fabian, Lears, Matsuda, Satter

16:510:515. COLLOQUIUM IN DIPLOMATIC HISTORY (3)
Curruthers, Foglesong

16:510:517. COLLOQUIUM IN ECONOMIC HISTORY (3)
Livingston, Triner-Besosa
Survey of the principal problems and methodologies in economic history.

16:510:519. COLLOQUIUM IN INTELLECTUAL HISTORY (3)
Bay, Lears, Livingston, Satter, Yans-McLaughlin
An investigation of consciousness—past and present—through the writings of philosophers, moralists, and cultural critics from the 17th through the 20th centuries.

16:510:521. COLLOQUIUM IN LABOR HISTORY (3)
Cobble, Livingston

16:510:523. COLLOQUIUM IN MIGRATION, COMMUNITY, AND IDENTITY (3)
Whalen, Yans-McLaughlin
Immigration, community, and identity formations among immigrants. Dynamics of assimilation and its opposites in selected cultural and chronological contexts.

16:510:525. COLLOQUIUM IN POLITICAL HISTORY (3)
O'Neill

16:510:527. TOPICS IN THE HISTORY OF RELIGION (3)
Lears, Mack, Morrison, Reinert
Selected issues and relevant historiography in the history of religion. Specific cultural and historical context varies according to the interests of the instructors.

16:510:529. TOPICS IN THE HISTORY OF SEXUALITY (3)
Jones, Reinert, Scott, Smith
Problems and historiography on the history of sexuality in selected historical and cultural contexts.

16:510:531. COLLOQUIUM IN SOCIAL HISTORY (3)
Gillis, Reed
Introduction to European and American social history, with emphasis on historical demography, the family, class structure and social stratification, protest, and culture.

16:510:532. COLLOQUIUM IN ATLANTIC HISTORY AND THE AFRICAN DIASPORA (3)
Bay, Bennett, Ca. Brown, Ch. Brown, Butler, Hewitt, Howard, Morgan, White
Examines the connected histories of Africa, Europe, and the Americas and the experiences of peoples of African descent.

16:510:533. TOPICS IN SOCIAL HISTORY (3,3)
Gillis, Reed

16:510:534. COLLOQUIUM IN ENVIRONMENTAL HISTORY (3)
Adas, Israel, Schrepfer, Scranton
Studies how environments and cultures have interacted throughout human history.

16:510:535. COLLOQUIUM IN THE HISTORY OF TECHNOLOGY (3)
Adas, Geselowitz, Israel, Scranton
Explores how culture has shaped technology as well as the social impacts of technology.

16:510:536. COLLOQUIUM IN THE HISTORY OF HEALTH AND MEDICINE (3)
J. Golden, Herschbach, Livingston, Marsh, Reed, Wailoo
How culture has shaped medical and scientific knowledge and how ideas about health and illness have influenced aspects of culture.

16:510:537. COLLOQUIUM IN URBAN HISTORY (3)
Howard, Isenberg
Introduction to the urbanization process, with emphasis on the city building process, social mobility and social structure, ethnicity, social and geographic mobility, political and social reform.

16:510:539. COLLOQUIUM IN WOMEN'S AND GENDER HISTORY (3)
Basch, Davis, Gillis, Jones, LeGall, J. Lewis, Morgan, Smith, White, Yans-McLaughlin
Women's and gender history across national/cultural contexts and time periods.

16:510:541. (F) COLLOQUIUM IN WORLD HISTORY (3)
Ch. Brown, Howard. Prerequisite: Admission to Ph.D. program.
Focuses on a specific problem or set of problems in world history using readings designed to promote an understanding of the relevant theoretical and analytical literature.

16:510:543. SEMINAR IN CULTURAL HISTORY (3)
Lears, Matsuda

16:510:545. SEMINAR IN ECONOMIC HISTORY (3)

16:510:546. SEMINAR I IN THE HISTORY OF TECHNOLOGY, ENVIRONMENT, AND HEALTH: HISTORY AND SOCIAL THEORY (3)
Israel, Pauly, Reed, Schrepfer, Scranton
Theoretical perspectives, drawn chiefly from the social sciences, emphasizing their role in initiating historical research projects.

16:510:547. SEMINAR II IN THE HISTORY OF TECHNOLOGY, ENVIRONMENT, AND HEALTH (3)
Israel, Pauly, Reed, Schrepfer, Scranton
Directed research related to the global history of technology, environment, and health.

16:510:549,550. SEMINAR IN THE HISTORY OF WOMEN (3,3)
Davis, Garrison, Hewitt, Jones, J. Lewis, Mack, Morgan, Smith, Yans-McLaughlin.

16:510:551. (S) SEMINAR IN WORLD AND COMPARATIVE HISTORY (3)
Adas, Ch. Brown, Howard, Roden. Prerequisite: Admission to Ph.D. program.
Directed research in projects related to a specific theme (such as immigration, imperialism, comparative gender ideologies) that are announced in advance by the instructor.

Courses in American History

16:510:555. PROBLEMS AND DIRECTED READINGS IN AMERICAN HISTORY I (3)
Ch. Brown, Clemens, J. Lewis, Morgan
Introduction to the history and historiography of 16th to 18th-century North America. Emphasis on encounters in early America between Europeans, Africans, and Native Americans; comparative experiences of Spanish (Caribbean and Mexico), French (Canada), and English; colonial society and politics; Atlantic economy and slavery; 18th-century revolutions and nation building. Designed to help students prepare for qualifying exams and to teach the U.S. survey.

16:510:557. PROBLEMS AND DIRECTED READINGS IN AMERICAN HISTORY II (3)
Basch, Clemens, W. Gillette, Hewitt, Lears, J. Lewis, Livingston, White
Introductory survey of history and historiography. America from the early 19th through early 20th centuries, covering key themes of political, military, social, and cultural development.

16:510:559. PROBLEMS AND DIRECTED READINGS IN AMERICAN HISTORY III (3)
Chambers, Foglesong, Gardner, Garrison, Lawson, J. Lewis, Livingston, O'Neill, Oshinsky, Yans-McLaughlin
Introductory survey of history and historiography. America from the early 20th century to the present, covering key themes of political, military, social, and cultural development.

16:510:560. PROBLEMS AND DIRECTED READINGS IN WOMEN'S AND GENDER HISTORY (3)
Hewitt, Jones, Mack, Morgan, Smith, Yans-McLaughlin
Introduction to the problems and concepts of women's history on an international scale.

16:510:561. COLLOQUIUM IN AMERICAN HISTORY (3)
Chambers, O'Neill, Schrepfer

16:510:563. COLLOQUIUM IN AFRICAN-AMERICAN HISTORY (3)
Bay, White

16:510:565. COLLOQUIUM IN AMERICAN LEGAL HISTORY (3)
Clemens
Focuses on the interplay between law and social change in American legal history.

16:510:567. SEMINAR IN AMERICAN COLONIAL HISTORY (3)
Clemens, J. Lewis

16:510:569. SEMINAR IN AMERICA IN THE CIVIL WAR (3)

16:510:571. SEMINAR IN RECENT AMERICAN HISTORY (3)
Markowitz, O'Neill, Yans-McLaughlin

16:510:573,574. SEMINAR IN AFRICAN-AMERICAN HISTORY (3,3)
Bay, White

16:510:575,576. SEMINAR IN AMERICAN DIPLOMATIC HISTORY (3,3)
Foglesong

16:510:577. SEMINAR IN AMERICAN ECONOMIC HISTORY (3)

16:510:579. SEMINAR IN THE INTELLECTUAL HISTORY OF THE UNITED STATES (3)
Lears

16:510:581. SEMINAR IN AMERICAN POLITICAL HISTORY (3)
Chambers, W. Gillette

16:510:583. SEMINAR IN AMERICAN SOCIAL HISTORY (3)
Jenkins, Reed

16:510:585. SEMINAR IN AMERICAN URBAN HISTORY (3)

Courses in European History

16:510:591. ANCIENT HISTORY: TOPICS AND PROBLEMS (3)
Cargill, Reinert
Colloquium structured around important primary and secondary readings in Greek and/or Roman history.

16:510:593. PROBLEMS AND DIRECTED READINGS IN MEDIEVAL HISTORY (3)
Masschaele, Morrison, Reinert
Introduction to the major problems and readings in the field of medieval history. Designed to prepare students to become competent and informed teachers in their major field.

16:510:595. COLLOQUIUM IN MEDIEVAL HISTORY (3)
Morrison, Reinert

16:510:597. PROBLEMS AND DIRECTED READINGS IN EARLY MODERN EUROPEAN HISTORY (3)
Davis, Gillis, Jones, Kelley, Smith
Introduction to the major problems and readings in the field of early modern European history. Designed to prepare students to become competent and informed teachers in their major field.

16:510:599. PROBLEMS AND DIRECTED READINGS IN MODERN EUROPEAN HISTORY (3)
Davis, Gillis, Jones, Kelley, Smith
Introduction to the major problems and readings in the field of modern European history. Designed to prepare students to become competent and informed teachers in their major field.

16:510:601. COLLOQUIUM IN EUROPEAN HISTORY (3)
Bell, Bellany, Galili, Jones, Mack, Matsuda

16:510:602. COLLOQUIUM IN THE HOLOCAUST: HISTORY, TESTIMONY, MEANING (3)

16:510:603. COLLOQUIUM IN BRITISH HISTORY (3)
Bellany, Gillis, Mack, Masschaele

16:510:605. COLLOQUIUM IN MODERN RUSSIAN HISTORY (3)
Galili
Introduction to the historical literature and major problems of 19th- and 20th-century Russian history. Designed to complement training in modern European or American history.

16:510:607. SEMINAR IN ANCIENT HISTORY (3)

16:510:611. SEMINAR: WESTERN EUROPE IN THE MIDDLE AGES (3)
Masschaele, Morrison, Reinert

16:510:613. SEMINAR IN RENAISSANCE REFORMATION HISTORY (3)

16:510:615,616. SEMINAR IN EUROPEAN HISTORY (3,3)
Davis, Mack

16:510:617. SEMINAR IN EUROPEAN INTELLECTUAL HISTORY (3)
Kelley, Morrison

16:510:619. SEMINAR IN EUROPEAN POLITICAL HISTORY (3)
Held

16:510:621. SEMINAR IN EUROPEAN SOCIAL HISTORY (3)
Bell, Gillis, Smith

16:510:623. SEMINAR IN ENGLISH HISTORY (3)

Courses in African, Asian, and Latin American History

16:510:625. COLLOQUIUM IN AFRICAN HISTORY (3)
Ca. Brown, Ch. Brown, Howard
Study of development prior to colonialism. Commercial systems and religious movements analyzed in the context of culture and social organization. Background for studying carryover of culture to the Americas; recent African history.

16:510:627. PROBLEMS AND DIRECTED READINGS IN EAST ASIAN HISTORY (3)
Roden
Basic introduction to the field of East Asian history.

16:510:629. COLLOQUIUM IN CHINESE HISTORY (3)
Introduction to major problems and readings in the field. Designed to prepare students to become competent and informed teachers of Chinese history.

16:510:631. COLLOQUIUM IN LATIN AMERICAN HISTORY (3)
Bennett, Triner-Besosa, Wasserman

16:510:633. SEMINAR IN AFRICAN HISTORY (3)

16:510:635. SEMINAR IN CHINESE HISTORY (3)
Research training in Chinese history. Topic of seminar varies depending on the instructor.

16:510:637,638. SEMINAR IN LATIN AMERICAN HISTORY (3,3)
Triner-Besosa, Wasserman

Individualized Study

16:510:677. ADVANCED TOPICS IN HISTORY (3)

16:510:678. ADVANCED TOPICS IN HISTORY (3)

16:510:679. ADVANCED TOPICS IN HISTORY (3)

16:510:701,702. RESEARCH IN HISTORY (BA,BA)
Open only to advanced students.
Designed to facilitate research work toward the doctoral dissertation.

HUMAN RESOURCE MANAGEMENT

(See the catalog of the School of Management and Labor Relations for information about the program leading to the master of human resource management.)

INDUSTRIAL AND SYSTEMS ENGINEERING 540

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Susan L. Albin, CoRE Building, Busch Campus (732/445-3654)**
Email: *salbin@rci.rutgers.edu*
Web Site: *http://coewww.rutgers.edu/ie*

Members of the Graduate Faculty

Susan L. Albin, *Professor of Industrial and Systems Engineering, SE; D.E.Sc., Columbia*
Quality engineering; stochastic models
Tayfur Altiok, *Professor of Industrial and Systems Engineering, SE; Ph.D., North Carolina State*
Production lines; production/inventory systems; queuing networks; simulation
Melike Baykal-Gürsoy, *Associate Professor of Industrial and Systems Engineering, SE; Ph.D., Pennsylvania*
Stochastic processes; stochastic optimization and control; applications to manufacturing, telecommunications, and transportation systems
Thomas O. Boucher, *Professor of Industrial and Systems Engineering, SE; Ph.D., Columbia*
Production analysis and control; automation and manufacturing systems; management and engineering economics
David W. Coit, *Assistant Professor of Industrial and Systems Engineering, SE; Ph.D., Pittsburgh*
Reliability engineering; optimization
Elsayed A. Elsayed, *Professor of Industrial and Systems Engineering, SE; Ph.D., Windsor*
Production analysis and control; automation and manufacturing systems; quality and reliability engineering
Mohsen A. Jafari, *Professor of Industrial and Systems Engineering, SE; Ph.D., Syracuse*
Manufacturing systems controller design and analysis; simulation; quality control
James T. Luxhoj, *Associate Professor of Industrial and Systems Engineering, SE; Ph.D., Virginia Polytechnic Institute and State University*
Maintenance, reliability, and systems safety; production economics; decision support systems
Tugrul Ozel, *Assistant Professor of Industrial and Systems Engineering, SE; Ph.D., Ohio State*
Modeling and control of manufacturing processes; precision machining; manufacturing automation

Hoang Pham, *Associate Professor of Industrial and Systems Engineering, SE;*
Ph.D., SUNY (Buffalo)
Reliability theory and applications; software reliability; applied probability
Fred Roberts, *Professor of Mathematics, FAS–NB; Ph.D., Stanford*
Discrete mathematical models; graph theory; decision making;
measurement theory

Programs

The mission of the program in industrial and systems engineering is to provide high quality education to graduate students and to conduct research, often in collaboration with industry and other disciplines, to advance the state of knowledge and practice in the field of industrial engineering.

The program aims to ensure that each student is educated in mathematical and scientific principles and at the same time is knowledgeable and confident to implement these principles to solve relevant engineering problems in industry and the public sector.

For doctoral students, we provide specialized training to prepare students to become capable independent researchers, and to be leaders in both the academic and industrial communities.

The department focuses its research in areas of critical importance to national competitiveness and productivity: modeling and systems engineering, production and manufacturing engineering, and quality and reliability engineering. Both the curriculum and laboratories are designed to support these research focuses.

In the modeling and systems area, projects are underway in supply chain and logistics engineering. In the aviation research areas, faculty members investigate and recommend policies on air traffic separation standards and aircraft inspection. Using simulation and analytic tools, projects are in progress in the areas of performance modeling of client-server computer networks, manufacturing systems performance, port operation, and modeling of intelligent transportation systems.

Research in the production and manufacturing engineering area is conducted at both the systems level and the machine level. Faculty members investigate problems and implement solutions in production planning and control; performance modeling of production systems; manufacturing process validation; computer-integrated manufacturing; automation; real-time machine control; and manufacturing processes such as laser micromachining, layered manufacturing, and sheet folding technologies.

In quality and reliability engineering, research is conducted and solutions are implemented in the areas of online process control, offline quality improvement through designed experiments, multivariate statistical models, stochastic control, reliability optimization, component and systems reliability, accelerated life testing, software reliability, data acquisition and analysis, maintenance models, and warranty estimation.

Industrial and systems engineering offers programs leading to the master of science and doctor of philosophy degrees. The Ph.D. degree requires a minimum of 48 credits beyond the B.S. degree in course work and 24 credits in research.

The M.S. degree requires a minimum of 30 course credits beyond the B.S. degree. Students may choose the thesis option. At least 18 of the 30 credits must be taken in the industrial and systems engineering program. The remaining credits may be taken in other graduate programs including statistics, mathematics, mechanical and electrical engineering, computer science, economics, and operations research.

The program offers four options for the M.S. degree. The industrial and systems engineering option offers the most flexibility providing students with knowledge in the major areas of the discipline including stochastic and deterministic models; in application areas such as production, quality, reliability, manufacturing, transportation, and aviation; and in a range of skills including simulation and statistical analysis.

The quality and reliability engineering option, offered in cooperation with the statistics department, includes courses in process control, design of experiments, quality management, and reliability.

The manufacturing systems engineering option includes courses in automation and computer integrated manufacturing and design, robotics, manufacturing processes, automation, and control. A special feature of this option is a required course where each student performs an independent study in the laboratory.

The information technology option educates students in the design, implementation, and improvement of information systems in the manufacturing and service industries. Students are trained in system integration, utilizing technologies in software engineering, system design and analysis to build a robust enterprise where information systems are seamlessly integrated into the enterprise functions. The option requires courses across disciplines including industrial and systems engineering, computer science, business, and telecommunications.

Extensive research facilities are available for student use in manufacturing automation, manufacturing processing, microcomputer/multimedia, facilities design, quality and reliability engineering, and microprocessors. Specialized equipment includes robotics, CNC machines, CAD facilities, microcomputers, and quality and reliability engineering metrology and life testing equipment, temperature chambers, vibration unit, scanning electron microscope, metal processing equipment, and materials handling.

To be admitted to the program, students must have completed a degree in engineering or related field and basic industrial and systems engineering courses including four terms of calculus; a high-level computer language; deterministic methods; probability; and engineering economics. Students who are missing prerequisite courses may be admitted to the graduate program, provided they take the prerequisites for no credit.

Applicants are invited to contact the graduate director and peruse the web site *http://coewww.rutgers.edu/ie.*

Graduate Courses

15:540:510. Deterministic Models in Industrial Engineering (3)
Altiok, Baykal-Gürsoy, Coit. Prerequisite: Introduction to linear programming.
Deterministic models of operations research. Linear programming, the simplex method, duality, sensitivity analysis, transportation assignment, minimum cost network flow problems.

16:540:515. Stochastic Models in Industrial Engineering (3)
Albin, Altiok, Baykal-Gürsoy, Coit, Jafari. Prerequisite: Calculus-based course in probability.
Stochastic models of operations research applied to queuing, reliability, inventory, and other problems. Markov chains, Markov processes, renewal processes.

16:540:520. Supply Chain and Logistics Engineering (3)
Boucher. Prerequisites: Probability and linear programming.
Methods and techniques of analysis applied to the design of inventory and distribution systems. Topics include sales forecasting, single- and multiechelon inventory and distribution systems, and routing and scheduling of product delivery.

16:540:525. Applied Queuing Theory (3)
Albin, Altiok, Baykal-Gürsoy. Prerequisite: 16:540:515.
Markovian and non-Markovian queuing models; networks of queues; numerical solutions, approximations; statistical estimation of system parameters; cost models; emphasis on queuing applications in manufacturing.

16:540:530. Forecasting and Time Series Analysis (3)
Baykal-Gürsoy, Luxhoj. Prerequisites: Advanced calculus, statistics.
Alternative time series models for purposes of prediction. Smoothing techniques, probability and regression analysis, and econometric analysis.

16:540:535. Network Applications in Industrial and Systems Engineering (3)
Altiok. Prerequisite: 14:540:311 or 16:540:510.
Flow problems in networks. Topics include shortest-route problems, critical path, and graph theory.

16:540:540. Computational Methods for Industrial Engineering (3)
Altiok, Jafari. Prerequisites: 16:540:510, 515.
Computational methods in modeling, planning, and control of production systems, numerical methods, artificial intelligence techniques, exact and heuristic search methods, and computational strategies.

16:540:542. ENTERPRISE INTEGRATION (3)
Prerequisite: 14:540:485.
Building and integrating information systems into manufacturing, engineering, and business functions in an enterprise. Methodological and practical aspects including client-server models, Internet-based three-tiered system architecture, legacy systems, data transfer, and distributed computing. Project involves prototyping of small enterprise information systems from design to implementation.

16:540:545. APPLICATION OF HUMAN FACTORS TO DECISION SYSTEMS ENGINEERING (3)
Introduction of human factors to engineering techniques. Decision-aiding concepts considered include prompting, expert systems, and artificial intelligence. Use of psychological scaling techniques in the development of a knowledge base for expert systems. Basic concepts in decision theory used in an analysis of decision elements of the FAAAir Traffic Control System and in the design of a panel or a keyboard.

16:540:550. SPECIAL PROBLEMS IN INDUSTRIAL ENGINEERING (BA)
Prerequisite: Permission of instructor.
Special investigations in selected areas of industrial engineering.

16:540:552. MANUFACTURING PROJECT (3)
Boucher, Elsayed, Jafari. Prerequisite: Permission of instructor.
Understanding of the state of technology in discrete, batch, and continuous manufacturing; hands-on experience.

16:540:555. SIMULATION OF PRODUCTION SYSTEMS (3)
Altiok, Elsayed, Jafari. Prerequisites: 14:540:311; 01:640:477 or 01:960:379; 01:640:481 or 01:960:381, 382, or equivalent; and FORTRAN or C.
Discrete event simulation applied to problems in manufacturing. SIMAN/ARENAsimulation tools. Estimation of manufacturing systems performance measures, analysis of production system operating characteristics, comparison of alternative systems, and validation of approximate analytic models. Case studies.

16:540:560. PRODUCTION ANALYSIS (3)
Boucher, Elsayed, Luxhoj. Prerequisite: Undergraduate production planning and control.
Analysis of production engineering, with emphasis on planning and control of manufacturing and service systems.

16:540:565. FACILITIES PLANNING AND DESIGN (3)
Coit, Luxhoj, Pham. Prerequisite: Deterministic models in operations research.
Operations research methodologies applied to facilities planning and design problems. Facilities layout and location problems, assembly-line balancing, conveyor design, and automated warehousing problems.

16:540:568. AUTOMATION AND COMPUTER-INTEGRATED MANUFACTURING I (3)
Boucher. Prerequisite: Introductory course in computer control or permission of instructor.
Design of automated and computer integrated manufacturing systems using programmable automation. Modeling of discrete and continuous control systems, implementation of programmable controllers and factory information systems.

16:540:570. APPLICATIONS OF ROBOTICS IN MANUFACTURING SYSTEMS (3)
Boucher, Jafari. Prerequisites: 14:540:343, 453, or equivalent.
Integration of robots in manufacturing systems, design of robot workstations, materials handling, and interactions among manufacturing cells. Machine vision with applications in manufacturing.

16:540:572. MANUFACTURING PROCESSES AND CONTROL (3)
Ozel. Prerequisite: Basic knowledge of manufacturing processes.
Overview of manufacturing processes, machine tools and machining operations, mechanism of metal cutting and tool wear, control and optimization of machining process, sensor-based and other advanced monitoring and control technology, manufacturing automation.

16:540:573. ADVANCED MANUFACTURING PROCESSES (3)
Ozel. Prerequisite: 14:540:303 or permission of instructor.
Introduction to unit manufacturing processes (mass-change, phase-change, structure-change, deformation, consolidation). Metal cutting and materials removal. Nontraditional manufacturing processes (laser, water jet, electrical discharge machining, electrochemical machining). Thin-film processing. Rapid prototyping. Process selection and planning. Emphasis on process physics and analytical and computational procedures to predict manufactured product quality and production rate.

16:540:575. ADVANCED ENGINEERING ECONOMICS I (3)
Boucher, Luxhoj. Prerequisite: Introductory course in engineering economics or equivalent.
Economic decision models for engineers involving allocation and scheduling of resources; evaluation of factual and strategic alternatives; advanced risk and uncertainty analysis; weighing and evaluating nonmonetary factors.

16:540:580. QUALITY MANAGEMENT (3)
Albin
Quality management philosophies, Deming, Juran; quality planning, control, and improvement; quality systems, management organizations for quality assurance. Role of operations research.

16:540:585. SYSTEM RELIABILITY ENGINEERING I (3)
Coit, Elsayed, Pham. Prerequisite: Advanced probability or 16:540:515.
Methods of measuring the reliability and effectiveness of complex engineering systems, including optimization theory, preventive maintenance models, and statistical analysis.

16:540:590. DESIGN OF ENGINEERING EXPERIMENTS (3)
Albin, Boucher. Prerequisite: Statistics.
The efficient design, analysis, and interpretation of engineering experiments using statistical methods. Analysis of variance and covariance. Designs commonly used in engineering experimentation. Analysis of response surface. Computer applications.

16:540:595. SOFTWARE RELIABILITY I (3)
Pham. Prerequisite: 16:540:515 or 16:960:580.
Software-reliability issues; software errors, faults, and failures; software design for reliability; data collection; formal methods for reliability; software fault tolerance; modeling growth in software reliability; cost modeling and estimation; and software quality management.

16:540:615. NONLINEAR PROGRAMMING (3)
Prerequisite: 14:540:311 or equivalent.
Approximate methods; Kuhn-Tucker theory; quadratic programming; integer linear programming; gradient methods; stochastic programming; computer solutions.

16:540:650. DISCRETE EVENT DYNAMIC SYSTEMS (3)
Jafari. Prerequisite: 16:540:515.
Supervisory control of discrete event dynamic systems, process monitoring, Petri nets, functional analysis, performance analysis, control specification, control verification and validation.

16:540:655. PERFORMANCE ANALYSIS OF MANUFACTURING SYSTEMS (3)
Altiok. Prerequisites: 16:540:515, 560, or equivalent.
Modeling of manufacturing systems such as flow shops, job shops, transfer lines, and production/inventory systems. Topics include problems of failures and repairs, the role of buffer inventories, capacity allocation, decomposition, approximations, pull-type systems, and the Kanban concept.

16:540:660. INVENTORY CONTROL (3)
Altiok, Baykal-Gürsoy. Prerequisites: 16:540:515, 525.
Modeling of pure inventory systems with stochastic demand and lead times. Characterization of optimal control policies and analysis of single as well as multi-item systems with simple and multiple echelons. Computational issues emphasized.

16:540:665. THEORY OF SCHEDULING (3)
Elsayed, Luxhoj. Prerequisite: Production planning and control.
Advanced topics in sequencing and scheduling for manufacturing and service systems; flow shop, job shop—static and dynamic models; multiprocessor parallel machining; preempt-resume algorithms; optimal due-date problems; probabilistic sequencing; simulation and applied operations research models.

16:540:668. AUTOMATION AND COMPUTER-INTEGRATED MANUFACTURING II (3)
Boucher, Jafari. Prerequisite: 16:540:568 or permission of instructor.
Design of automated and computer-integrated manufacturing systems using programmable automation. Modeling, specification, and implementation of factory information systems. Reference models and control architecture for discrete parts manufacturing, batch process manufacturing, and semiconductor manufacturing industries.

16:540:673. LASER-BASED MICROMANUFACTURING (3)
Prerequisite: Permission of instructor.
Introduction to laser materials processing, micromanufacturing, and MEMS. Advances and opportunities made possible by application of laser-based micromanufacturing processes. Applications of laser micromachining, laser thin-film processing, laser microheat treatment, laser microwelding, laser microrapid prototyping. Process modeling, planning, and integration issues.

16:540:675. ADVANCED ENGINEERING ECONOMICS II (3)
Boucher, Luxhoj. Prerequisite: 16:540:575 or permission of instructor.
Focuses on engineering economic decision making. Application of analytical techniques to the evaluation of industrial projects, the relationship of project selection to long-range planning, and the relationship between the economics of technical choice and industrial productivity.

16:540:680. PRODUCTION AND QUALITY ENGINEERING (3)
Albin, Elsayed. Prerequisites: Production planning and control, operations research.
Integration of research in quality and production. Topics include models that relate quality and inventory policies, scheduling, setup costs, lot sizing, production cycles, scrap, rework, repair, location of inspection stations, process control, and electronics testing and manufacturing.

16:540:682. PROCESS MODELING AND CONTROL (3)
Baykal-Gürsoy. Prerequisite: 16:540:515.
Stationary (ARMA), nonstationary (ARIMA) time-series models for process control, various automatic process control (APC) strategies, statistical process control (SPC) methods, integration of APC and SPC.

16:540:685. SYSTEM RELIABILITY ENGINEERING II (3)
Coit, Elsayed, Pham. Prerequisite: 16:540:585.
Advanced topics in reliability theory and engineering; reliability optimization; theory of preventive maintenance, replacement, and inspection; accelerated life reliability models; renewal processes; and maximum likelihood estimation.

16:540:690. COMPONENT RELIABILITY (3)
Baykal-Gürsoy, Coit, Elsayed, Pham. Prerequisite: 16:540:585.
Emphasizes reliability estimation of components stressed through different types of stresses such as thermal, electric field, humidity, vibration, and fatigue. Burn-in testing, reliability estimation from degradation data, and relationships between accelerated stresses and normal operating conditions.

16:540:691,692. SEMINAR IN INDUSTRIAL AND SYSTEMS ENGINEERING (0,0)
Lectures by graduate students, faculty, and invited speakers on current research topics in industrial and systems engineering.

16:540:694. ADVANCED TOPICS IN INDUSTRIAL ENGINEERING (3)
Prerequisite: Permission of instructor.
Seminar for doctoral students in a selected area of industrial engineering. Based on current literature.

16:540:701,702. RESEARCH IN INDUSTRIAL ENGINEERING (BA,BA)

INDUSTRIAL RELATIONS AND HUMAN RESOURCES 545

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Susan Jackson,**
  Janice Levin Building, Livingston Campus (732/445-5447)

Members of the Graduate Faculty

John R. Aiello, *Professor of Psychology, FAS–NB; Ph.D., Michigan State*
  Industrial and organizational psychology; environmental stress; nonverbal communication
Clayton P. Alderfer, *Professor of Psychology, GSAPP; Ph.D., Yale*
  Organizational behavior and organizational change
Eileen Appelbaum, *Professor of Labor and Employment Relations, SMLR; Ph.D., Pennsylvania*
  High performance work systems; women and work
Richard W. Beatty, *Professor of Human Resource Management, SMLR; Ph.D., Washington*
  Human resource systems and planning; performance appraisal; compensation
David Bensman, *Associate Professor of Labor Studies and Employment Relations, SMLR; Ph.D., Columbia*
  Labor history; contemporary collective-bargaining issues; schools and education
Joseph Blasi, *Professor of Labor-Management Relations, SMLR; Ed.D., Harvard*
  Employee ownership; employee participation in management and governance
John Burton, *Professor of Industrial Relations and Human Resources, SMLR; Ph.D., Michigan*
  Workers compensation; public sector collective bargaining
Paula Caligiuri, *Assistant Professor of Human Resource Management, SMLR; Ph.D., Pennsylvania State*
  International human resources; selection
Cary Cherniss, *Professor of Psychology, GSAPP; Ph.D., Yale*
  Job stress and burnout; careers; organizational change; supervision
Sue Cobble, *Associate Professor of Labor Studies and Employment Relations, SMLR; Ph.D., Stanford*
  Women and work; labor history; union leadership
Steven M. Director, *Professor of Human Resource Management, SMLR; Ph.D., Northwestern*
  Human resource policy, planning, and evaluation; financial analysis of human resources and labor relations decisions
Adrienne E. Eaton, *Associate Professor of Labor and Employment Relations, SMLR; Ph.D., Wisconsin*
  Collective bargaining; worker and union participation in management; union organizing
Charles H. Fay, *Associate Professor of Human Resource Management, SMLR; Ph.D., Washington*
  Compensation, performance appraisal, human resource information systems
Charles Heckscher, *Professor of Labor Studies and Employment Relations, SMLR; Ph.D., Harvard*
  Workplace transformation; new forms of employment representation
Mark Huselid, *Associate Professor of Human Resource Management, SMLR; Ph.D., SUNY (Buffalo)*
  Strategic human resource management
Susan E. Jackson, *Professor of Human Resource Management, SMLR; Ph.D., California (Berkeley)*
  Strategic human resource management; work teams; workforce diversity; stress and burnout
Jeffrey H. Keefe, *Associate Professor of Industrial Relations and Human Resources, SMLR; Ph.D., Cornell*
  Work restructuring and technology; collective bargaining; telecommunications; labor relations
Mark R. Killingsworth, *Professor of Economics, FAS–NB; D.Phil., Oxford*
  Labor and human resources; discrimination
Douglas L. Kruse, *Associate Professor of Industrial Relations and Human Resources, SMLR; Ph.D., Harvard*
  Profit-sharing; employee ownership; disability and employment
Barbara A. Lee, *Professor of Human Resource Management and Dean, SMLR; Ph.D., Ohio State*
  Employment law; employee relations
Charles A. Nanry, *Professor of Human Resource Management, SMLR; Ph.D., Rutgers*
  Social organization; training policy; general management

Jean Phillips, *Assistant Professor of Human Resource Management, SMLR; Ph.D.,*
Michigan State
Leadership; teams; learning organizations; job search/recruitment
Saul Rubinstein, *Assistant Professor of Labor Studies and Employment Relations,*
SMLR; Ph.D., Massachusetts Institute of Technology
Work systems; organizational transformation
Randall S. Schuler, *Professor of Human Resource Management, SMLR; Ph.D.,*
Michigan State
Strategic and international human resource management
Carl Edward Van Horn, *Professor of Public Policy, EJBSPPP; Ph.D., Ohio State*
American political institutions, public policy
Paula Voos, *Professor of Labor Studies and Employment Relations, SMLR;*
Ph.D., Harvard
Collective bargaining; labor markets
John D. Worrall, *Professor of Economics, FAS–C; Ph.D., Rutgers*
Worker's compensation; property-casualty insurance; labor economics

Associate Members of the Graduate Faculty

Niki Dickerson, *Assistant Professor of Labor Studies and Employment Relations,*
SMLR; Ph.D., Michigan
Labor market demographics, economic sociology, survey research and design
Stan M. Gully, *Assistant Professor of Human Resource Management, SMLR;*
Ph.D., Michigan State
Leadership and team effectiveness; training and development; multilevel theory
and analysis
David Lepak, *Assistant Professor of Human Resource Management, SMLR;*
Ph.D., Pennsylvania State
Strategic human resource management
Hui Liao, *Assistant Professor of Human Resource Management, SMLR;*
Ph.D., Minnesota
Service performance, work group dynamics, diversity
Claudia G. Meer, *Associate Extension Specialist, SMLR; Ed.D., Rutgers*
Education in industry; training and development; adult learning
Lisa Schur, *Assistant Professor of Labor Studies and Employment Relations,*
SMLR; J.D., Northwestern; Ph.D., California (Berkeley)
Labor law and employment law; work and disability
James Sesil, *Assistant Professor of Human Resource Management, SMLR;*
Ph.D., London School of Economics
Strategic human resource management; pay systems

Program

The Ph.D. in industrial relations and human resources is a full-time, interdisciplinary program committed to developing scholars who can study the dynamic and changing conditions of employment and work.

The program prepares students to conduct research that contributes to the advancement of knowledge and practice in industrial relations and human resource management. In addition to studying the fundamental theories of industrial relations and human resource management, students learn how to design and conduct rigorous research, to analyze their results, and to disseminate their findings through scholarly publications. Students are expected to be actively involved in research throughout their enrollment in the program.

Required course work for the program includes seven courses to fulfill interdisciplinary distribution requirements, at least three statistics and research methods courses, two advanced seminars, and four electives. During their second year in the program, students complete an empirical research project. After completing their master's thesis and required course work, students take a qualifying examination tailored to their research interests. Upon passing the qualifying examination, students are awarded the M.S. degree and admitted to Ph.D. candidacy. Students complete a dissertation during their fourth and fifth years.

Graduate Courses

16:545:601,602. INDUSTRIAL STUDY IN INDUSTRIAL RELATIONS AND HUMAN RESOURCES (3,3)
Directed study under the supervision of a faculty member.

16:545:610. PROSEMINAR IN INDUSTRIAL RELATIONS AND HUMAN RESOURCES (0.5)
Research, theoretical, or pedagogical presentation by SMLR faculty, outside scholars, and advanced Ph.D. students. Students must enroll for eight terms.

16:545:611. SEMINAR IN INDUSTRIAL RELATIONS: A SURVEY OF THE SCHOLARLY LITERATURE (3)
Industrial relations systems theory. Analysis of managerial capitalism and the diffusion of systematic management techniques; the development of modern craft, industrial, and professional labor organizations; and the emergence of the regulatory state and the role of law and specialized government agencies in regulating industrial conflict. Conceptual framework to assess bargaining power, negotiations processes, grievance procedures, and conflict resolution.

16:545:612. SEMINAR IN HUMAN RESOURCES: A SURVEY OF THE SCHOLARLY LITERATURE (3)
Industrial and organizational psychological foundations of human resources developed. Critical review of the research literature on recruiting, selection, performance management, compensation, and development. Analysis of firm performance.

16:545:613. RESEARCH METHODS FOR INDUSTRIAL RELATIONS AND HUMAN RESOURCES (3)
Prerequisite: One Ph.D.-level statistics or measurement course.
Problems of research design, data collection, data management, and the selection of analytical techniques.

16:545:614. MULTIVARIATE ANALYSIS FOR INDUSTRIAL RELATIONS AND HUMAN RESOURCES (3)
Prerequisites: Ph.D.-level course in regression and one additional Ph.D.-level measurement or statistics course.
Multiple regression, analysis of variance, analysis of covariance, factor analysis, canonical correlation, and cluster analysis.

16:545:615. ECONOMICS FOR INDUSTRIAL RELATIONS AND HUMAN RESOURCES (3)
Alternative theories of the firm and labor markets explored, with focus on competing hypotheses and research evidence about wage and benefit determination, internal labor markets, discrimination, unions, and employee incentive systems.

16:545:621. SELECTED PROBLEMS IN INDUSTRIAL RELATIONS AND HUMAN RESOURCES (3)
Special topics in industrial relations and human resources of current interest.

16:545:701,702. RESEARCH IN INDUSTRIAL RELATIONS AND HUMAN RESOURCES (3,3)
Dissertation study.

INTERDISCIPLINARY PH.D. PROGRAM 554

Special interdisciplinary Ph.D. programs may be arranged for individual students who wish to pursue subjects that cut across the boundaries of program curricula.

Astudent who seeks the Ph.D. in an area requiring the services of two or more programs should consult interested faculty members and then submit a formal proposal to the dean of the Graduate School–New Brunswick outlining a program of study. Courses, examinations, the dissertation topic, and the names of faculty members who have consented to serve as the student's committee must have the approval of the directors of the Ph.D. programs involved. Once approved by the dean, the student will be transferred into the interdisciplinary Ph.D. program code (554) for registration purposes. Amember of the Graduate School–New Brunswick academic staff serves as graduate director of this program.

Contact the Office of the Graduate School–New Brunswick, 25 Bishop Place, New Brunswick, NJ 08903, for further information, or call 732/932-7275.

ITALIAN 560

Degree Programs Offered: **Master of Arts, Master of Arts for Teachers, Doctor of Philosophy**
Director of Graduate Program: **Professor Laura S. White,**
84 College Avenue, College Avenue Campus (732/932-7536)

Members of the Graduate Faculty

Andrea Baldi, *Associate Professor of Italian, FAS–NB; Dott. in Lettere, Firenze; Ph.D., California (Los Angeles)*
Sixteenth- and 17th-century literature

Franco Ferrucci, *Professor Emeritus of Italian, FAS–NB; Dott. in Lettere, Pavia*
Dante studies; 19th- and 20th-century literature

Guido A. Guarino, *Professor Emeritus of Italian, FAS–NB; Ph.D., Columbia*
Humanism and Renaissance literature

Elizabeth Leake, *Assistant Professor of Italian, FAS–NB; Ph.D., California (Berkeley)*
Twentieth-century literature and film

Umberto Mariani, *Professor Emeritus of Italian, FAS–NB; Dott. in Lettere, Pavia*
Nineteenth- and 20th-century literature

David R. Marsh, *Professor of Italian, FAS–NB; Ph.D., Harvard*
Influence of classical literature in Renaissance Italy from Petrarch to Tasso

Alessandro Vettori, *Assistant Professor of Italian, FAS–NB; Dott. in Lettere, Florence; Ph.D., Yale*
Thirteenth-century literature; Dante and Franciscan literature

Laura S. White, *Chairperson of Department and Professor of Italian, FAS–NB; Dott. in Lettere, Trieste; Ph.D., California (Los Angeles)*
Petrarca, Boccaccio, epic poetry; 17th- and 18th-century literature

Programs

The graduate faculty in Italian offers three degree programs. The M.A.T. program is intended primarily for those who are teaching, or intend to teach, at the secondary school level. The program emphasizes language, literature, and civilization. The M.A. and Ph.D. programs deal with all aspects of Italian literature and literary criticism. All three programs are open to candidates with academic records of distinction and other evidence of scholarly accomplishment. The master of philosophy degree is available to doctoral candidates in Italian who, in addition to meeting the other M.Phil. requirements of the Graduate School–New Brunswick, achieve grades of *A* in at least nine term courses.

Candidates for the M.A.T. must complete satisfactorily 10 term courses (30 credits) and take an examination based on a reading list. Master of arts candidates also take 10 term courses (30 credits) and must pass a comprehensive examination based on a reading list. Six of the 30 credits required for the M.A. may be devoted to a research problem if the candidate elects to write a thesis.

Doctoral candidates usually are required to complete 48 credits of course work beyond the bachelor's degree and do a minimum of 24 credits of research toward the dissertation. In addition, they must be in residence for one year. Credit for graduate work taken at other institutions may be accepted in partial fulfillment of the course requirement, but in no case may the doctoral candidate do less than a full year of course work at Rutgers. Doctoral candidates must demonstrate a reading knowledge of German, Greek, or Latin and reading proficiency in a second Romance language. The language requirement must be satisfied before the candidate is admitted to the qualifying examination. This examination is based on a reading list covering all periods of Italian literature. Once a student fulfills the course requirements, including the residence requirement, and passes the qualifying examination, he or she is admitted to candidacy for the Ph.D. degree and then may proceed with the preparation of a dissertation.

Reading lists on which the examinations are based, as well as the *Guide for Graduate Students in Italian,* are available at the office of the program director. The graduate program in Italian participates in the Transliteratures program.

Graduate Courses

15:560:501,502. HISTORY OF THE ITALIAN LANGUAGE (3,3)
Marsh
Development of the Italian language from its origins to the present day, with emphasis on the phonological, morphological, syntactical, and lexical growth of the literary tongue.

16:560:503,504. ADVANCED GRAMMAR AND COMPOSITION (3,3)
Advanced grammar, with special attention to problems of idiomatic expression and literary style; themes, oral presentations, and translation.

16:560:506. (F) APPLIED LINGUISTICS IN ITALIAN (3)
Contrastive analysis of the phonology, morphology, and syntax of English and Italian, oriented toward actual teaching problems in the classroom.

16:560:507,508. INTRODUCTION TO ROMANCE PHILOLOGY (3,3)
Introduction to the typology of the Romance languages. *First term:* history and structure of the Romance languages. *Second term:* readings of parallel texts with studies of special problems.

16:560:509,510. ITALIAN CIVILIZATION (3,3)
Survey of Italian civilization, with emphasis on its expression through the arts from the 13th century to the present.

16:560:511,512. APPROACHES TO LITERATURE (3,3)
Poetry and prose from various periods of Italian literature, with examples of interpretive and textual scholarship and criticism, and various methods of literary study.

16:560:513,514. STYLISTICS AND LITERARY CRITICISM (3,3)
Prerequisite: 16:560:504 or permission of instructor.
Elements of style and theory of grammar; rhetoric and structure of literature; stylistic analysis and practice in literary criticism.

16:560:515,516. ITALIAN LITERATURE FROM THE 13TH TO THE 16TH CENTURIES (3,3)
Survey of the first four centuries of Italian literature. *First term:* late medieval literary currents. *Second term:* the age of humanism and the Renaissance.

16:560:517,518. ITALIAN LITERATURE FROM THE 17TH TO THE 20TH CENTURIES (3,3)
Survey of the main literary currents and major writers of modern and contemporary Italy. *First term:* from the baroque to romanticism. *Second term:* from *Verismo* to the present.

16:560:521. (F) PROBLEMS OF TEACHING ITALIAN (N1.5)
Objectives, teaching techniques, testing, and student evaluation in elementary and intermediate language and literature courses. Bibliographical and other professional resources. Observation of classes.

16:560:522. (S) TEACHING APPRENTICESHIP IN ITALIAN (N1.5)
Observation of elementary and intermediate language classes; supervised practice teaching.

16:560:601,602. STUDIES IN EARLY ITALIAN LITERATURE (3,3)
Vettori, White
The beginnings of Italian literature in the 13th century; poetry and prose before Dante, the Sicilian School, and the *dolce stil nuovo.*

16:560:605,606. DANTE SEMINAR (3,3)
Vettori
Medieval thought as represented in Dante's works.

16:560:610,611. THE CLASSICAL TRADITION IN ITALIAN LITERATURE (3,3)
Marsh
Survey of Greek and Roman literary genres (epic, lyric, tragedy, comedy, history, pastoral, epyllion, satire, dialogue, and novel) and their influence on Italian literature from the late Middle Ages to the present.

16:560:613,614. ITALIAN LITERATURE OF THE 14TH CENTURY (3,3)
White
First term: **Petrarca.** *Second term:* **Boccaccio.**

16:560:615,616. ITALIAN LITERATURE OF THE 15TH CENTURY (3,3)
Marsh
First term: the development of humanism (Bruni, Valla, Alberti, Pico della Mirandola, Ficino, and others). *Second term:* the poets (Lorenzo, Poliziano, Pulci, Boiardo, and others).

16:560:621,622. ITALIAN LITERATURE OF THE 16TH CENTURY (3,3)
Baldi
The flowering of the Renaissance (the Reformation, Ariosto, Machiavelli, Guicciardini, Castiglione, Della Casa, Bembo, Aretino, Tasso, and others).

16:560:625,626. ITALIAN EPIC AND CHIVALRIC POETRY (3,3)
Baldi, White
Medieval origins of the genre and its evolution during the Renaissance through Pulci's *Morgante,* Boiardo's *Orlando Innamorato,* Ariosto's *Orlando Furioso,* and Tasso's *Gerusalemme Liberata.*

16:560:631. ITALIAN LITERATURE OF THE 7TH CENTURY (3)
White
Works of Campanella, Marino, Galileo, and baroque theater.

16:560:632,633. ITALIAN LITERATURE OF THE 18TH CENTURY (3,3)
White
Works of Vico, Goldoni, Gozzi, Parini, Alfieri, and others.

16:560:641,642. THE ROMANTIC AGE (3,3)
First half of the 19th century. Neoclassic school and European romantic poetics: Foscolo, Leopardi, and Manzoni. Major dialect poets: Porta, Belli. Poets, critics, and ideologues of the *Risorgimento.*

16:560:643,644. ITALIAN LITERATURE OF THE LATE 19TH CENTURY (3,3)
Baldi, Ferrucci
The *Scapigliatura.* The major poets: Carducci, Pascoli, and D'Annunzio and their relationship to European decadentism and symbolism. Poetics of naturalism and *Verismo:* Verga, D'Annunzio, Fogazzaro, and Capuana.

16:560:645,646. STUDIES IN ITALIAN LITERATURE OF THE 19TH CENTURY (3,3)
Each term deals in depth with one or two major literary figures or movements of 19th-century Italian literature.

16:560:647. ITALIAN WOMEN WRITERS IN THE 19TH AND 20TH CENTURIES (3)
Baldi
Analysis of works by Neera, Serao, Aleramo, Deledda, Banti, Morante, De Céspedes, Ginzburg, Maraini, and Ortese. Emphasis on historical and theoretical issues of women's writing.

16:560:651,652. ITALIAN POETRY OF THE 20TH CENTURY (3,3)
Poetic models of D'Annunzio and Pascoli, and the reaction of the *crepuscolari* poets. Poetic movements of futurism and *La Voce,* the *Ronda* restoration. Major figures of Ungaretti and Montale. Hermetic school and the poetry of Quasimodo. Antehermetic and posthermetic developments. The *Novissimi* and later trends.

16:560:653,654. ITALIAN NOVEL OF THE 20TH CENTURY (3,3)
D'Annunzian model and the anti-D'Annunzian novels of Borgese, Svevo, Pirandello, Tozzi. Differing regional trends and the traditional novel in the 20th century. The *Novecento* movement and the novels of Manzini and Buzzati. Neorealists, the postwar generation, and contemporary trends.

16:560:655,656. MODERN ITALIAN THEATER (3,3)
Italian naturalistic and bourgeois theater from its late 19th-century origins to the major works of Verga, D'Annunzio, Giacosa, and Bracco. The "grotesque" theater, Pirandello, and the contemporary theater from Betti, Fabbri, and De Filippo to Zardi, Squarzina, and Testori.

16:560:657,658. ITALIAN LITERATURE OF THE 20TH CENTURY (3,3)
Reaction to the 19th-century models in poetry, fiction, and theater; establishment of new models of writing in the cultural climate that followed futurism and World War I; the hermeticism of the 1930s and the neorealism of the 1940s; major literary figures and trends of recent decades.

16:560:661,662. THE ITALIAN SHORT STORY (3,3)
The origins, development, and influence of the Italian short story from the *Novellino* to today.

16:560:671,672. HISTORY OF ITALIAN CRITICISM (3,3)
Survey of modern Italian critical thought, starting with the pre-romantic aesthetics of Vico in the early 18th century and concluding with the 20th-century contributions of Croce and the post-Croceans.

16:560:673,674. PROBLEMS IN LITERARY RELATIONSHIPS (3,3)
Independent study under the supervision of a faculty member of the relationship between Italian literature and the literature of France or Spain.

16:560:701,702. RESEARCH IN ITALIAN (BA,BA)

LABOR AND EMPLOYMENT RELATIONS
(See the catalog of the School of Management and Labor Relations for information about the program leading to the master of labor and employment relations.)

LIBRARY STUDIES
(See the catalog of the School of Communication, Information and Library Studies for information about programs leading to the master of library service.)

LINGUISTICS 615

Degree Programs Offered: **Master of Arts *, Doctor of Philosophy**
Director of the Graduate Program: **Professor Bruce Tesar,**
  18 Seminary Place, College Avenue Campus (732/932-7289)

Members of the Graduate Faculty

Akinbiyi M. Akinlabi, *Associate Professor of Linguistics, FAS–NB; Ph.D., Ibadan*
  Phonology; tone; intonation in tone languages; Benue Congo phonology; Yoruba
Mark Baker, *Professor of Linguistics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
  Comparative syntax; linguistic universals; semantic roles; Amerindian and African languages
Maria Bittner, *Professor of Linguistics, FAS–NB; Ph.D., Texas (Austin)*
  Crosslinguistic semantics; pragmatics; ergativity; Eskimo and other exotic languages
Jose Camacho, *Assistant Professor of Linguistics/Spanish and Portuguese, FAS–NB; Ph.D., Southern California*
  Spanish syntax; second-language acquisition; language contact; Amazonian linguistics
Veneeta Dayal, *Professor of Linguistics, FAS–NB; Ph.D., Cornell*
  Syntax-semantics interface; semantics; South-Asian linguistics

* Students do not enroll for the M.A.; a terminal master's degree is offered.

Viviane M. Déprez, *Associate Professor of Linguistics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Syntactic theory; Romance linguistics; language acquisition; Creole syntax
Jane Grimshaw, *Professor of Linguistics, FAS–NB; Ph.D., Massachusetts*
Syntactic theory; the lexicon; language acquisition; cognitive science
Alan S. Prince, *Professor of Linguistics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Phonology; prosody; prosodic morphology; optimality theory; cognitive science
Kenneth Safir, *Professor of Linguistics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Syntactic theory; Germanic linguistics; Romance linguistics; history of linguis-tics; learnability theory
Roger Schwarzschild, *Associate Professor of Linguistics, FAS–NB; Ph.D., Massachusetts*
Semantics; pragmatics; intonation
Bruce Tesar, *Associate Professor of Linguistics, FAS–NB; Ph.D., Colorado*
Learnability and acquisition; computational linguistics; cognitive science; phonology

Associate Members of the Graduate Faculty

Young-mee Yu Cho, *Associate Professor of East Asian Languages and Culture, FAS–NB; Ph.D., Stanford*
Phonology; morphology; Korean linguistics; synchronic variation; diachrony
Matthew Stone, *Assistant Professor of Computer Science, FAS–NB/RuCCS; Ph.D., Pennsylvania*
Natural-language generation; conversational dialogue agents; knowledge representation and logic programming
Karin Stromswold, *Associate Professor of Psychology, FAS–NB; Ph.D., Massachusetts Institute of Technology; M.D., Harvard*
Language acquisition; cognitive and neural bases of language; functional neuroimaging

Program

The graduate program in linguistics offers a comprehensive pro-gram of study leading to the Ph.D. in the major areas of theoretical linguistics. It is structured to facilitate the student's involvement in research through work undertaken in close contact with members of the faculty. The program is designed to prepare graduates for careers in research and teaching at the university level in linguis-tics or in linguistically oriented subfields within the larger enter-prise of cognitive science. Before specializing, students are expected to develop broad expertise in all of the core areas of phonology, syntax, and semantics.

Graduate Courses

16:615:505. LINGUISTICS COLLOQUIUM (3)
Discussion and presentation of research in progress by advanced graduate students, visitors, and faculty members.

16:615:510. SYNTAX I (3)
Introduction to syntactic theorizing and analysis. Provides funda-mental background in phrase structure theory, predicate argument structure, grammatical function changing, conditions on anaphora, case marking, thematic roles, and long-distance dependencies.

16:615:511. SYNTAX II (3)
Prerequisite: 16:615:510.
Intermediate-level discussion of major issues in syntactic theory, including theories of parametric variation, logical form and levels of grammar, and components and subtheories of grammar.

16:615:515. SEMINAR IN SYNTACTIC THEORY (3)
Prerequisite: 16:615:511 or permission of instructor.
Advanced-level discussion of current issues in syntactic theory. Topics vary.

16:615:517. TOPICS IN GERMANIC SYNTAX (3)
Prerequisite: Working knowledge of generative grammar.
Further study of Germanic phenomena in the construction of syn-tactic theory. Emphasis on construction types that are of the great-est theoretical and crosslinguistic interest.

16:615:520. PHONOLOGY I (3)
Introduction to major phonological phenomena and concepts of current theory, with emphasis on the development of analytical skills.

16:615:521. PHONOLOGY II (3)
Prerequisite: 16:615:520.
In-depth investigation of leading issues in current theory, with focus on the structure of representations and the organization of the phonological component of the grammar.

16:615:525. SEMINAR IN PHONOLOGY (3)
Prerequisite: 16:615:521 or permission of instructor.
Exploration of a special topic arising from current research in phonological theory.

16:615:530. SEMANTICS I (3)
Introduction to model-theoretic semantics. Topics include elemen-tary set theory, predicate logic, and their applications in the analy-sis of major semantic phenomena.

16:615:531. SEMANTICS II (3)
Prerequisite: 16:615:530.
Mathematical tools for relating syntactic structure to semantic interpretation. Topics include higher-order logic, lambda calculus, intensional logic, type theory, type driven translation, type lifting, and lattices.

16:615:532. TOPICS IN SEMANTICS I (3)
Prerequisite: 16:615:531 or permission of instructor.
Selected topics in model-theoretic semantics. Questions, focus, presupposition, conversational implicature, context dependence, and context change.

16:615:533. TOPICS IN SEMANTICS II (3)
Prerequisite: 16:615:531 or permission of instructor.
Selected topics in model-theoretic semantics, modals, conditionals, indexicals, tense, aspect, and genericity.

16:615:535. SEMINAR IN SEMANTICS (3)
Prerequisite: 16:615:532 or 533 or permission of instructor.
Exploration of current issues in semantic theory. Topics vary.

16:615:610. FORMAL METHODS FOR LINGUISTICS (3)
Prerequisites: 16:615:511, 521, 531, or permission of instructor.
Selected topics in logic, algebra, formal languages, computation, mathematical analysis, statistics, and/or formal learning theory, with applications to linguistics.

16:615:631. FIELD METHODS FOR LINGUISTICS (3)
Prerequisites: 16:615:511, 521, 531, or permission of instructor.
Analysis of the linguistic structure of an unfamiliar language, based on in-class work with a native-speaker consultant.

16:615:660. SPECIAL TOPICS IN CURRENT LINGUISTIC THEORY (3)
Prerequisites: 16:615:511, 521, 531, or permission of instructor.
Topics in current linguistic research that cross subdisci-plinary boundaries.

16:615:670. SEMINAR IN LEARNABILITY AND LINGUISTIC THEORY (3)
Prerequisite: 16:615:520 or permission of instructor.
Examines approaches to language learning, focusing on relation-ships between learning proposals and linguistic theory. Includes concepts from computational learning theory relevant to understanding the learning implications of contemporary linguistic theory.

16:615:690,691. QUALIFYING PAPER WORKSHOP (3,3)
Prerequisites: 16:615:511, 521, 531.
Students working on qualifying papers present work in progress for discussion and criticism.

LITERATURES IN ENGLISH
(See English, Literatures in 350)

MATHEMATICS 640, 642

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Charles A. Weibel,**
Hill Center for the Mathematical Sciences, Busch Campus
(732/445-3864)

Members of the Graduate Faculty

Eric Allender, *Professor of Computer Science, FAS–NB; Ph.D., Georgia Institute of Technology*
Complexity theory; parallel and probabilistic computation

Abbas Bahri, *Professor of Mathematics, FAS–NB; Doctorat, École Normale Supérieure*
Variational problems in nonlinear analysis and geometry

Tadeusz Balaban, *Professor of Mathematics, FAS–NB; Ph.D., Warsaw*
Mathematical physics

José Barros-Neto, *Professor Emeritus of Mathematics, FAS–NB; Ph.D., São Paulo*
Functional analysis; partial differential equations

R. Michael Beals, *Professor of Mathematics, FAS–NB; Ph.D., Princeton*
Harmonic analysis; Fourier integral operators; partial differential equations

József Beck, *Harold H. Martin Professor of Mathematics, FAS–NB; Ph.D., Hungarian Academy of Sciences*
Combinatorics, combinatorial games, number theory

Adi Ben-Israel, *Professor of Management, SB–NB; Ph.D., Northwestern*
Matrix theory; numerical linear algebra, convexity and optimization operations research, mathematical economics

Edward Boylan, *Associate Professor of Mathematics, FAS–N; Ph.D., Princeton*
Probability and computer science

Haim Brezis, *Distinguished Visiting Professor of Mathematics, FAS–NB; Doctorat, Paris*
Nonlinear functional analysis; partial differential equations

Felix E. Browder, *Professor of Mathematics, FAS–NB; Ph.D., Princeton*
Functional analysis and partial differential equations

Richard T. Bumby, *Professor of Mathematics, FAS–NB; Ph.D., Princeton*
Number theory

Terence Butler, *Professor of Mathematics, FAS–NB; Ph.D., Indiana*
Differential equations

Sagun Chanillo, *Professor of Mathematics, FAS–NB; Ph.D., Purdue*
Classical analysis; partial differential equations

Gregory L. Cherlin, *Professor of Mathematics, FAS–NB; Ph.D., Yale*
Logic; model theory; model theoretic algebra

Vašek Chvátal, *Professor of Computer Science, FAS–NB; Ph.D., Waterloo*
Combinatorial optimization; combinatorics

Amy Cohen, *Professor of Mathematics, UC–NB; FAS–NB; Ph.D., California (Berkeley)*
Partial differential equations; inverse scattering; Korteweg-de Vries equation

Richard M. Cohn, *Professor Emeritus of Mathematics, FAS–NB; Ph.D., Columbia*
Differential algebra

Bernard Coleman, *J. Willard Gibbs Professor of Thermomechanics, SE; Ph.D., Yale*
Continuum mechanics, analysis

Ovidiu Costin, *Associate Professor of Mathematics, FAS–NB; Ph.D., Rutgers*
Exponential asymptotics; asymptotic analysis; mathematical physics

Jane Cronin, *Professor Emerita of Mathematics, FAS–NB; Ph.D., Michigan*
Qualitative theory of ordinary differential equations; biomathematics

Carl C. Faith, *Professor Emeritus of Mathematics, FAS–NB; Ph.D., Purdue*
Theory of rings and modules

Richard S. Falk, *Chair of Department and Professor of Mathematics, FAS–NB; Ph.D., Cornell*
Numerical analysis; partial differential equations

Paul Feehan, *Associate Professor of Mathematics, FAS–NB; Ph.D., Columbia*
Partial differential equations; gauge theory and applications to four-manifolds; non-abelian monopoles

Steven Ferry, *Joshua Barlaz Professor of Mathematics, FAS–NB; Ph.D., Michigan*
Geometric topology; differential topology; differential geometry

Michael L. Fredman, *Professor of Computer Science, FAS–NB; Ph.D., Stanford*
Data structures and algorithms; computational complexity

Giovanni Gallavotti, *Distinguished Visiting Professor of Mathematics, FAS–NB; Ph.D., Florence*
Statistical mechanics; quantum field theory; dynamical systems

Israel M. Gelfand, *Professor of Mathematics, FAS–NB; Ph.D., Moscow State*
Mathematics; artificial intelligence; neuroanatomy; cell biology

Jane P. Gilman, *Professor of Mathematics, FAS–N; Ph.D., Columbia*
Riemann surfaces; Fuchsian groups; Teichmuller theory; geometric topology; combinatorial group theory

Simon G. Gindikin, *Professor of Mathematics, FAS–NB; Ph.D., Mathematics Institute (Leningrad)*
Theory of representations; integral geometry; several complex variables; mathematical physics

Gerald A. Goldin, *University Director, Science and Mathematics Partnerships, and Professor of Mathematics and Physics Education, GSE; Ph.D., Princeton*
Lie theory; mathematical physics; secondary education

Sheldon Goldstein, *Professor of Mathematics, FAS–NB; Ph.D., Yeshiva*
Statistical mechanics; probability theory

Roe Goodman, *Professor of Mathematics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Representation theory and analysis on Lie groups

Stephen A. Greenfield, *Professor of Mathematics, FAS–NB; Ph.D., Brandeis*
Linear partial differential equations; several complex variables

Richard F. Gundy, *Professor of Statistics, FAS–NB; Ph.D., Chicago*
Wavelets and time-frequency analysis; probability theory

András Hajnal, *Professor of Mathematics, FAS–NB; Ph.D., Bolyai Institute (Szeged)*
Combinatorics; mathematical logic; set theory

Peter Hammer, *Professor of Mathematics, FAS–NB, and Director of the Rutgers Center for Operations Research; Ph.D., Bucharest*
Boolean methods in operations research; integer programming; applications of discrete mathematics; graph theory

Zheng-Chao Han, *Associate Professor of Mathematics, FAS–NB; Ph.D., Courant Institute (New York)*
Nonlinear analysis; partial differential equations

William Hoyt, *Associate Professor Emeritus of Mathematics, FAS–NB; Ph.D., Chicago*
Algebraic geometry; elliptic surfaces; modular forms

Xiaojun Huang, *Associate Professor of Mathematics, FAS–NB; Ph.D., Washington (St. Louis)*
Several complex variables

Yi-Zhi Huang, *Associate Professor of Mathematics, FAS–NB; Ph.D., Rutgers*
Conformal field theory; mathematics underlying string theory

Henryk Iwaniec, *State of New Jersey Professor of Mathematics, FAS–NB; Ph.D., Warsaw*
Analytic number theory

Howard J. Jacobowitz, *Professor of Mathematics, FAS–C; Ph.D., New York*
Differential geometry

Jeffry N. Kahn, *Professor of Mathematics, FAS–NB; Ph.D., Ohio State*
Combinatorics and related fields

Johannes H.B. Kemperman, *Professor Emeritus of Statistics, FAS–NB; Ph.D., Amsterdam*
Probability and statistics

Michael Kiessling, *Associate Professor of Mathematics, FAS–NB; Ph.D., Ruhr (Bochum)*
Statistical mechanics

Friedrich Knop, *Professor of Mathematics, FAS–NB; Ph.D., Basel (Switzerland)*
Algebraic geometry; representation theory

János Komlós, *Professor of Mathematics, FAS–NB; Ph.D., Eötvös*
Combinatorics; probability; theoretical computer science

Maxim Kontsevich, *Distinguished Visiting Professor of Mathematics, FAS–NB; Ph.D., Bonn*
String theory and quantum field theory; quantum cohomology

Antoni A. Kosinski, *Professor Emeritus of Mathematics, FAS–NB; Ph.D., Warsaw*
Differential topology

Martin Kruskal, *David Hilbert Professor of Mathematics, FAS–NB; Ph.D., New York*
Soliton equations; asymptotic analysis; surreal numbers

Antti Kupiainen, *Distinguished Visiting Professor of Mathematics, FAS–NB; Ph.D., Princeton*
Mathematical physics; quantum field theory; statistical mechanics

Peter S. Landweber, *Professor of Mathematics, FAS–NB; Ph.D., Harvard*
Algebraic topology; bordism theory; generalized homology theory

Solomon Leader, *Professor Emeritus of Mathematics, FAS–NB; Ph.D., Princeton*
Analysis; abstract spaces

Joel L. Lebowitz, *George William Hill Professor of Mathematics and Director of the Center for Mathematical Sciences Research, FAS–NB; Ph.D., Syracuse*
Mathematical physics; statistical mechanics

James I. Lepowsky, *Professor of Mathematics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Representational theory; vertex operator algebras; mathematics underlying string theory

Norman Levitt, *Professor of Mathematics, FAS–NB; Ph.D., Princeton*
Differential and geometric topology; surgery theory; structural theory

Yanyan Li, *Professor of Mathematics, FAS–NB; Ph.D., New York*
Nonlinear analysis; partial differential equations

Feng Luo, *Associate Professor of Mathematics, FAS–NB; Ph.D., California (San Diego)*
Topology and geometry

Richard N. Lyons, *Professor of Mathematics, FAS–NB; Ph.D., Chicago*
Simple groups
Benjamin Muckenhoupt, *Professor Emeritus of Mathematics, FAS–NB; Ph.D., Chicago*
Harmonic analysis; orthogonal expansions; weighted norm inequalities
Roger Nussbaum, *Professor of Mathematics, FAS–NB; Ph.D., Chicago*
Nonlinear functional analysis
Daniel L. Ocone, *Professor of Mathematics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Stochastic processes; stochastic control; filtering
Michael E. O'Nan, *Professor of Mathematics, FAS–NB; Ph.D., Princeton*
Permutation groups; simple groups
Barbara L. Osofsky, *Professor of Mathematics, FAS–NB; Ph.D., Rutgers*
Ring theory; homological algebra
Ted Petrie, *Professor of Mathematics, FAS–NB; Ph.D., Princeton*
Algebraic and differential topology; transformation groups; equivariant surgery; financial mathematics
Andras Prekopa, *Professor of Operations Research and Statistics, FAS–NB; Ph.D., Budapest*
Optimization of stochastic systems
John D. Randall, *Associate Professor of Mathematics, FAS–N; Ph.D., Warwick*
Topology; algebraic geometry
Vladimir Retakh, *Associate Professor of Mathematics, FAS–NB; Ph.D., Moscow Pedagogical Institute*
Noncommutative algebra and combinatorics; special functions and differential equations; mathematics education
Fred S. Roberts, *Professor of Mathematics, FAS–NB, and Director of DIMACS; Ph.D., Stanford*
Discrete mathematical models; graph theory; decision making; measurement theory
Xiaochun Rong, *Associate Professor of Mathematics, FAS–NB; Ph.D., SUNY (Stony Brook)*
Riemannian geometry
Joseph Rosenstein, *Professor of Mathematics, FAS–NB, and Associate Director of Education, DIMACS; Ph.D., Cornell*
Logic; linear orderings; recursive model theory
David Ruelle, *Distinguished Visiting Professor of Mathematics, FAS–NB; Ph.D., Brussels*
Statistical mechanics; dynamical systems
Siddhartha Sahi, *Professor of Mathematics, FAS–NB; Ph.D., Yale*
Representations of reductive groups
Michael Saks, *Professor of Mathematics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Combinatorial optimization and algorithms; extremal set theory; partially ordered sets
Vladimir Scheffer, *Professor of Mathematics, FAS–NB; Ph.D., Princeton*
Geometric measure theory; partial differential equations
David Shanno, *Professor of Management, SB–NB; Ph.D., Carnegie Mellon*
Mathematical programming, numerical analysis
Saharon Shelah, *Distinguished Visiting Professor of Mathematics, FAS–NB; Ph.D., Hebrew (Jerusalem)*
Logic; model theory
Diana F. Shelstad, *Professor of Mathematics, FAS–N; Ph.D., Yale*
Harmonic analysis on algebraic groups related to number theory and geometry
Lawrence Shepp, *Professor of Statistics, FAS–NB; Ph.D., Princeton*
Pure and applied probability; tomography; mathematics of finance
Charles C. Sims, *Professor of Mathematics, FAS–NB; Ph.D., Harvard*
Computational group theory and algebraic algorithms
Avraham Soffer, *Professor of Mathematics, FAS–NB; Ph.D., Tel Aviv*
Theory of partial differential evolution equations; Schrödinger operators and scat - tering theory; general mathematical physics
Eduardo D. Sontag, *Professor of Mathematics, FAS–NB; Ph.D., Florida*
System and control theory
Eugene R. Speer, *Professor of Mathematics, FAS–NB; Ph.D., Princeton*
Mathematical physics
Hector J. Sussmann, *Professor of Mathematics, FAS–NB; Ph.D., New York*
System and control theory
William J. Sweeney, *Professor Emeritus of Mathematics, FAS–NB; Ph.D., Stanford*
Linear partial differential equations; overdetermined systems
Endre Szemerédi, *State of New Jersey Professor of Computer Science, FAS–NB; Ph.D., Budapest*
Theoretical computer science; number theory; combinatorics
Earl J. Taft, *Professor of Mathematics, FAS–NB; Ph.D., Yale*
Hopf algebras
A. Shadi Tahvildar-Zadeh, *Associate Professor of Mathematics, FAS–NB; Ph.D., Princeton*
Nonlinear hyperbolic partial differential equations
Jean E. Taylor, *Professor Emerita of Mathematics, FAS–NB; Ph.D., Princeton*
Geometric measure theory
Simon Thomas, *Professor of Mathematics, FAS–NB; Ph.D., London*
Model theory; infinite groups
Myles Tierney, *Professor of Mathematics, FAS–NB; Ph.D., Columbia*
Topos theory

Gabor Toth, *Professor of Mathematics, FAS–C; Ph.D., Eötvös Loránd*
Differential geometry
J. François Trêves, *Robert Adrain Professor of Mathematics, FAS–NB; Ph.D., Sorbonne*
Functional analysis; linear partial differential equations; several complex variables
Jerrold B. Tunnell, *Associate Professor of Mathematics, FAS–NB; Ph.D., Harvard*
Number theory; automorphic forms
Wolmer V. Vasconcelos, *Professor of Mathematics, FAS–NB; Ph.D., Chicago*
Commutative algebra; computational algebra
Michael Vogelius, *Board of Governors Professor of Mathematics, FAS–NB; Ph.D., Maryland*
Numerical analysis; partial differential equations
Charles A. Weibel, *Professor of Mathematics, FAS–NB; Ph.D., Chicago*
Algebraic K-theory; homological algebra; algebraic topology; category theory
Richard L. Wheeden, *Professor of Mathematics, FAS–NB; Ph.D., Chicago*
Harmonic analysis; harmonic functions; weighted norm inequalities
Robert L. Wilson, *Professor of Mathematics, FAS–NB; Ph.D., Yale*
Lie algebras
Christopher T. Woodward, *Associate Professor of Mathematics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Symplectic geometry; geometric quantization
Norman Zabusky, *State of New Jersey Professor of Computational Fluid Dynamics, SE; Ph.D., California Institute of Technology*
Vortex dynamics in two and three dimensions
Doron Zeilberger, *Board of Governors Professor of Mathematics, FAS–NB; Ph.D., Weizmann Institute*
Algebraic and enumerative combinatorics; experimental mathematics
Hyman J. Zimmerberg, *Professor Emeritus of Mathematics, FAS–NB; Ph.D., Chicago*
Boundary value problems

Associate Members of the Graduate Faculty

Lisa Carbone, *Assistant Professor of Mathematics, FAS–NB; Ph.D., Columbia*
Group actions on trees
Martin Farach-Colton, *Associate Professor of Computer Science, FAS–NB; Ph.D., Maryland*
Computational molecular biology; sequential and partial algorithms
William F. Keigher, *Associate Professor of Mathematics, FAS–N; Ph.D., Illinois*
Differential and commutative algebra, category theory; algebraic geometry
Haisheng Li, *Assistant Professor of Mathematics, FAS–C; Ph.D., Rutgers*
Vertex operator algebras; mathematics related to string theory
Stephen D. Miller, *Assistant Professor of Mathematics, FAS–NB; Ph.D., Princeton*
Automorphic forms; L-functions
Jacob Sturm, *Associate Professor of Mathematics, FAS–N; Ph.D., Princeton*
Number theory, automorphic forms

Programs

The graduate program in mathematics offers courses of study leading to the degrees of master of science and doctor of philosophy. Possible areas of specialization include algebraic geometry, category theory and topos theory, commutative algebra, theory of computation, differential geometry, discrete mathematics, functional analysis, geometric measure theory, group theory, harmonic analysis on Euclidean spaces, Lie theory, logic, mathematical physics, nonlinear analysis, number theory, numerical analysis, ordinary differential equations, operations research, partial differential equations, probability theory, ring theory, mathematics underlying string theory, system and control theory, and algebraic and geometric topology.

The program in mathematics is housed in the Hill Center for the Mathematical Sciences, a seven-story building on the Busch campus. Hill Center and the adjoining CoRE Building house the computer science and statistics departments, the Center for Discrete Mathematics and Theoretical Computer Science, and the Mathematical Sciences Library. The library contains more than 27,000 volumes and subscribes to more than 300 research journals in pure and applied mathematics. Office space is provided to all full-time graduate students in mathematics. The graduate programs in biology, chemistry, physics, and engineering are located nearby.

Applicants to the Ph.D. programs must have a strong undergraduate background in mathematics and must submit scores from both the general and subject tests of the Graduate Record Examination (GRE). Financial aid through fellowships and teaching assistantships is available to qualified doctoral students. Application for financial support should be made by February 1.

Applicants to the master's programs should have an undergraduate degree in mathematics or a related area. Preferably, they should have taken courses in linear algebra and advanced calculus. Both the general and subject tests of the GRE are required for master's applicants.

It also is possible to apply for admission as a nondegree student. The GRE is not required for these applicants. As many as 12 credits of course work taken as a nondegree student can count toward a degree if the student is subsequently admitted to a degree program.

All doctoral students must pass a two-stage qualifying examination before officially commencing work on their thesis. The first examination, a written one, is designed to ensure that Ph.D. graduates know certain basic material. Normally, it is taken at the beginning of the student's second year. The second examination, which is oral, normally is taken by the beginning of the second term of the student's third year.

Students pursuing a Ph.D. in mathematics must take 48 credits in approved courses. Normally, this curriculum will include 16:640:501,502 Theory of Functions of a Real Variable, 16:640:503 Theory of Functions of a Complex Variable I, and 16:640:551,552 Abstract Algebra. Students should choose a program that gives them knowledge in a broad range of mathematics and/or its applications. In addition, students in the sequence must take 16:640:616,617 Seminar in Mathematics; acquire a reading knowledge of French, German, or Russian; complete 24 credits of research; and submit a doctoral dissertation. There is no residency requirement. Ordinarily, the courses 16:642:527,528 Methods of Applied Mathematics, 16:642:550 Linear Algebra and Applications, and 16:642:593 Mathematical Foundations for Industrial and Systems Engineering are not approved for the Ph.D. program in mathematics.

For the M.S. in mathematics, students select, with the approval of the graduate director, 30 credits of course work. At least 18 of these credits must come from courses offered by the Graduate Program in Mathematics. Specific requirements are: (1) one of the following courses: 16:640:501 Theory of Functions of a Real Variable I, 16:640:503 Theory of Functions of a Complex Variable I, 16:640:515 Ordinary Differential Equations, and 16:642:516 Applied Partial Differential Equations; (2) 16:640:551 Abstract Algebra I; and (3) a course in computer science, statistics, or some other area of applied mathematics offered by the department. There is no residency requirement, but a master's essay is required.

Not all graduate courses listed below are given every year. Each course is scheduled subject to student demand and at the discretion of the graduate faculty.

Graduate Courses (640)

16:640:501,502. THEORY OF FUNCTIONS OF A REAL VARIABLE (3,3)
Prerequisite: Advanced calculus.
Real number system, measure theory, and Lebesgue integration in Euclidean and abstract spaces, set functions, bounded variation, absolute continuity, differentiation of the indefinite integral. Radon measure, L^p spaces.

16:640:503. THEORY OF FUNCTIONS OF A COMPLEX VARIABLE I (3)
Prerequisite: Advanced calculus.
Elementary properties of complex numbers, analytic functions, the exponential function and logarithm, conformal mapping, Cauchy integral formula, maximum modulus principle, Laurent series, classification of isolated singularities, residue theorem.

16:640:504. THEORY OF FUNCTIONS OF A COMPLEX VARIABLE II (3)
Prerequisite: 16:640:503.
Analytic continuation and the monodromy theorem, normal families and Riemann mapping theorem, Picard theorems, and other topics.

16:640:507,508. FUNCTIONAL ANALYSIS (3,3)
Prerequisites: 16:640:502, 503, 540.
First term: introductory Hilbert space theory, including the Riesz representation theorem and the spectral theory of compact symmetric operators. Fundamental principles of linear analysis: Hahn-Banach, uniform boundedness, and closed-graph theorems. Weak topologies, Riesz theory of compact operators. *Second term:* Banach algebra, spectral theory of operators on Hilbert space, other selected topics and applications.

16:640:509,510,511. SELECTED TOPICS IN ANALYSIS (3,3,3)
Prerequisites: 16:640:502 and permission of instructor.

16:640:513. NUMERICAL FUNCTIONAL ANALYSIS (3)
Prerequisite: Permission of instructor.
Bases in Banach spaces. Constructive solution of equations involving symmetric and nonsymmetric linear operators and nonlinear compact, P-compact, monotone-accretive, and A-proper operators. Constructive fixed-point theory. Eigenvalue problems. Application to differential and integral equations.

16:640:515. ORDINARY DIFFERENTIAL EQUATIONS (3)
Prerequisites: Linear algebra and advanced calculus.
Theory of ordinary and functional differential equations: basic existence theorems, linear systems, stability theory, periodic and almost-periodic solutions. Applications to biology, medicine, and physics.

16:640:517,518. PARTIAL DIFFERENTIAL EQUATIONS I,II (3,3)
Pre- or corequisites: 16:640:502, 503, 507.
Theory of distributions, Fourier transform, fundamental solutions of the heat, wave, and Laplace equations. The Cauchy problem, theorems of Cauchy-Kovalevska and Holmgren, hyperbolic equations. Elliptic boundary value problems and Sobolev spaces.

16:640:519. SELECTED TOPICS IN DIFFERENTIAL EQUATIONS (3)
Prerequisite: Permission of instructor.
Topics in ordinary and partial differential equations chosen by the instructor.

16:640:520. DISTRIBUTION THEORY (3)
Prerequisites: 16:640:501,502.
Spaces of distribution; temperated distributions; Sobolov spaces; spaces of test functions; topology and duality of these spaces. Kernel theorems. Growth conditions; the Fourier transform.

16:640:521. HARMONIC ANALYSIS ON EUCLIDEAN SPACES (3)
Pre- or corequisite: 16:640:502.
Maximal functions, fractional integrals, singular integrals, multipliers, Littlewood-Paley theory, H^p spaces, weighted norm inequalities, Fourier series, differentiation.

16:640:523,524. FUNCTIONS OF SEVERAL COMPLEX VARIABLES (3,3)
Pre- or corequisites: 16:640:502, 503, 507.
Elementary theorems (Hartogs, Osgood), statement of Cousin and Levi problems, complex differential geometry, complex manifolds, holomorphic convexity.

16:640:529. POTENTIAL THEORY (3)
Prerequisites: 16:640:502, 504.
Harmonic and superharmonic functions in R^n; polar sets, potentials, capacities, Green's functions, balayage, thin sets, and the fine topology. Energy and the Dirichlet integral. The Dirichlet problem in R^n, L^p boundary values and nontangential maximal functions for C^1 and Lip^1 boundaries. Ideal boundaries.

16:640:532. DIFFERENTIAL GEOMETRY (3)
Differentiable manifolds, connections, Riemannian manifolds.

16:640:533. INTRODUCTION TO DIFFERENTIAL GEOMETRY (3)
Riemannian manifolds, variational methods and theorems on geodesics, connections on vector and principal bundles, curvature, Euler, and other characteristic numbers and classes.

16:640:534. SELECTED TOPICS IN GEOMETRY (3)
Prerequisite: Permission of instructor.
Selected topics, including Lie groups, representation theory, homogeneous spaces, and semi-Riemannian manifolds.

16:640:535,536. ALGEBRAIC GEOMETRY (3,3)
Prerequisite: Permission of instructor.
Geometry of projective spaces; cohomology of coherent sheaves; schemes.

16:640:537. SELECTED TOPICS IN GEOMETRY (3)

16:640:540,541. INTRODUCTION TO ALGEBRAIC TOPOLOGY (3,3)
Prerequisite: Basic concepts of point set topology.
Fundamental group, homology, and cohomology theory; elements of differentiable manifolds.

16:640:542,543. ALGEBRAIC TOPOLOGY (3,3)
Prerequisites: 16:640:504, 541.
Further topics of algebraic and differential topology, including duality theorems, homotopy theory, vector bundles, characteristic classes, and applications to geometric problems.

16:640:544. TRANSFORMATION GROUPS (3)
Prerequisite: 16:640:541. Corequisite: 16:640:549.
Actions of compact Lie groups on manifolds.

16:640:546. TOPICS IN ALGEBRAIC TOPOLOGY (3)
K-theory, spectral sequences, cohomology operations, various other topics.

16:640:547. TOPOLOGY OF MANIFOLDS (3)
Prerequisite: 16:640:541.
Selected topics from the theory of topological and combinatorial manifolds.

16:640:548. DIFFERENTIAL TOPOLOGY (3)
Prerequisites: 16:640:540,541.
Vector bundles, differentiable manifolds. Sard's theorem and applications to imbedding problems. Tubular neighborhoods. Other selected topics.

16:640:549. LIE GROUPS (3)
Prerequisites: 16:640:532, 541.
Lie groups. Lie algebras, elements of representation theory.

16:640:550. LIE ALGEBRAS (3)
Prerequisites: Linear algebra, 16:640:551,552.
Introduction to the general structure theory of Lie algebras and to the structure theory of finite-dimensional semisimple Lie algebras over the complex numbers.

16:640:551,552. ABSTRACT ALGEBRA (3,3)
Introductory topics in groups, rings, modules, linear algebra, fields, Galois theory, and homological algebra.

16:640:553. THEORY OF GROUPS (3)
Prerequisite: 16:640:551.
Solvable groups, Nilpotent groups, p-groups, transfer and fusion, permutation groups. Topics chosen from among group representations and character theory, primitive permutation groups, local groups, theoretic analysis of simple groups, infinite groups.

16:640:555. SELECTED TOPICS IN ALGEBRA (3)
Prerequisite: Permission of instructor.

16:640:556. THEORY OF RINGS (3)
Prerequisite: 16:640:552.
Irreducible modules, representations of rings, radicals of rings. Artinian and semisimple rings, quotient rings.

16:640:558. THEORY OF ALGEBRAS (3)
Prerequisite: Permission of instructor.
General theory of not necessarily associative algebras and rings. Topics selected from the theory of associative, Lie, alternative, and Jordan algebras. Structure and representation theory.

16:640:559. COMMUTATIVE ALGEBRA (3)
Prerequisite: 16:640:552.
Ideal theory, Noetherian rings, local rings, regular local rings, valuation theory, polynomial and power series rings, Gröbner bases, computations in polynomial rings.

16:640:560. HOMOLOGICAL ALGEBRA (3)
Prerequisite: 16:640:552.
Projective and injective modules, the derived functions Ext and Tor, categories and functors. Morita theorems, homological dimension.

16:640:561. MATHEMATICAL LOGIC (3)
Metamathematics and first-order arithmetic and analysis, with emphasis on the questions of consistency and completeness. Introduction to model theory and its application to the study of formal systems.

16:640:566. AXIOMATIC SET THEORY (3)
Prerequisite: 16:640:561.
Axioms of Zermelo-Fraenkel, axioms of infinity consistency and independence of the continuum hypothesis, Dedekind-finite cardinals, large cardinals.

16:640:567. MODEL THEORY (3)
Prerequisite: 16:640:561.
Types of elements, prime and saturated models, methods of constructing models, the two-cardinal problem, categoricity and power.

16:640:569. SELECTED TOPICS IN LOGIC (3)
Prerequisite: Permission of instructor.
Topics of current interest.

16:640:571,572. NUMBER THEORY (3,3)
Prerequisites: 16:640:551,552.
Integrated, yearlong introduction to ideas in algebraic and analytic number theory.

16:640:573. SPECIAL TOPICS IN NUMBER THEORY (3)
Iwaniec. Prerequisite: Permission of instructor.

16:640:574. SPECIAL TOPICS IN NUMBER THEORY (3)
Prerequisite: Permission of instructor.

16:640:615. SPECIAL STUDIES IN ADVANCED MATHEMATICS (BA)

16:640:616,617. SEMINAR IN MATHEMATICS (1,1)
Prerequisite: Two years of graduate study in mathematics.
Two-term participation in one of the seminars conducted by the department required of all candidates for the Ph.D.

16:640:651. CATEGORY THEORY (3)
Prerequisite: Some background in algebra and topology.
Basic theory of categories, functors, and natural transformations. Abstract theory interpreted and illustrated through examples.

16:640:663. TOPICS IN MATHEMATICAL PHYSICS (3)

16:640:699. NONTHESIS STUDY (1)

16:640:701,702. RESEARCH IN MATHEMATICS (BA,BA)

Graduate Courses in Applied Mathematics (642)

16:642:516. APPLIED PARTIAL DIFFERENTIAL EQUATIONS (3)
Prerequisites: Advanced calculus, differential equations.
Theory and applications of partial differential equations. First order equations: linear and quasi-linear. Hyperbolic systems: shocks. Classification of second-order linear equations. Hyperbolic: characteristics, wave equation. Elliptic: maximum principles, Laplace's and reduced-wave equations. Parabolic: heat equation. Fourier and Laplace transforms.

16:642:527,528. METHODS OF APPLIED MATHEMATICS (3,3)
Prerequisite: Permission of instructor. Credit not given for these courses and 16:650:567,568.
Appropriate topics from linear algebra, linear operators in Hilbert space, linear integral equations, boundary-value problems, calculus of variations, numerical solution of ordinary and partial differential equations.

16:642:550. LINEAR ALGEBRA AND APPLICATIONS (3)
Vector spaces, bases, and dimension. Linear operators, quadratic forms, and their matrix representations. Eigenvalues, eigenvectors, diagonalizability, Jordan, and other canonical forms. Applications to systems of linear differential equations.

16:642:551. APPLIED ALGEBRA (3)
Prerequisite: 16:642:550.
Basic algebraic structures, including groups and their representations, finite fields, and Boolean algebra. Applications to physics, counting arguments, switching circuits, and coding theory. Automata theory.

16:642:561-562. INTRODUCTION TO MATHEMATICAL PHYSICS (3,3)
Prerequisites: Linear algebra, advanced calculus.
Study of models of classical and/or quantum mechanical physical systems, with emphasis on the use of rigorous mathematical techniques.

16:642:563. (F) RIGOROUS RESULTS IN STATISTICAL MECHANICS I: EQUILIBRIUM (3)
Prerequisite: Permission of instructor. Students should have either a general mathematical background equivalent to that of a second-year graduate student in mathematics or knowledge of statistical mechanics obtained from physics, chemistry, or engineering courses in the subject.
Treats the subject *ab initio.* Deals with general questions such as the existence of the thermodynamic limit, covergence of low-density expansions, correlation inequalities, coexistence of phases.

16:642:564. (S) RIGOROUS RESULTS IN STATISTICAL MECHANICS II: NONEQUILIBRIUM (3)
Prerequisite: Permission of instructor. Students should have either a general mathematical background equivalent to that of a second-year graduate student in mathematics or knowledge of statistical mechanics obtained from physics, chemistry, or engineering courses in the subject.
Ergodic theory, time evolution of infinite systems, heat flow in random systems, stationary nonequilibrium systems, exactly soluble models systems, stochastic processes.

16:642:573,574. NUMERICAL ANALYSIS (3,3)
Prerequisites: Advanced calculus, linear algebra, and differential equations.
Ideas and techniques of numerical analysis illustrated by problems in the approximation of functions, numerical solution of linear and nonlinear systems of equations, approximation of matrix eigenvalues and eigenvectors, numerical quadrature, and numerical solution of ordinary differential equations.

16:642:575. NUMERICAL SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS (3)
Prerequisite: Partial differential equations.
Finite-difference schemes, investigating stability and convergence, other methods such as those of Ritz-Galerkin type and collocation.

16:642:577,578. SELECTED MATHEMATICAL TOPICS IN SYSTEM THEORY (3,3)
Prerequisites: Linear algebra, differential equations.
Selection of topics from mathematical system theory (e.g., realization, control, stability, optimization, and feedback), with emphasis on qualitative aspects. Algebraic techniques in linear system theory, geometrical and functional analytic techniques in the study of nonlinear control systems.

16:642:581. (S) GRAPH THEORY (3)
Prerequisites: 01:640:350 and 411, or permission of instructor. 01:640:477 is recommended.
Advanced introduction to graph theory. Topics include matching theory, connectivity, graph coloring, planarity, extremal graph theory, and the main techniques (elementary, probabilistic, algebraic, and polyhedral) for analyzing the structure and properties of graphs.

16:642:582,583. COMBINATORICS (3,3)
Prerequisites: 01:640:350 and 411, or permission of instructor. 01:640:477 and 16:640:551 are recommended.
Advanced introduction to combinatorial theory and applications. Typical topics include hypergraphs, probabilistic methods, algebraic methods, matching theory, packing and covering, Ramsey theory, partially ordered sets and lattices, block designs, error-correcting codes, and matroids. Topics and emphasis vary depending on instructor.

16:642:585. MATHEMATICAL MODELS OF SOCIAL AND POLICY PROBLEMS (3)
Prerequisites: Linear algebra, elementary probability.
Mathematical models of problems in social sciences and the public and private policy areas, emphasizing discrete models. Transportation and communication networks. Energy modeling. Pollution models. Models from economics, psychology, sociology, and political science, dealing with such issues as currency movement, land development, learning, small group behavior, and power in legislatures. Development of requisite mathematical tools about graphs, signed graphs, Markov chains, and n-person games.

16:642:586. (S) THEORY OF MEASUREMENT (3)
Prerequisite: Undergraduate modern algebra or permission of instructor.
Foundations of measurement from a mathematical point of view. Homomorphisms or relational systems; scale type; uniqueness theory; ordinal, extensive, difference, and conjoint measurements; utility and expected utility; subjective probability; applications to social and physical sciences.

16:642:587. SELECTED TOPICS IN DISCRETE MATHEMATICS (3)
Prerequisite: Permission of instructor.
Choice of topics depends on year and instructor.

16:642:588. (F) INTRODUCTION TO MATHEMATICAL TECHNIQUES IN OPERATIONS RESEARCH (3)
Prerequisite: Linear algebra.
Deterministic methods in operations research, emphasizing linear programming. Hyperplanes, duality, complementary slackness, simplex method, dual simplex method. Integer programs. Assignment, network, and transportation problems. Emphasis on theoretical underpinnings.

16:642:589. (S) TOPICS IN MATHEMATICAL TECHNIQUES IN OPERATIONS RESEARCH (3)
Prerequisites: 16:642:588 or equivalent, permission of instructor.
Special mathematical topics such as matching, matroids, dynamic programming, recent work in combinatorial optimization.

16:642:591,592. TOPICS IN PROBABILITY AND ERGODIC THEORY (3,3)
Corequisites: 16:640:501,502.
Basic probability theory and its applications. Topics include stochastic independence, distributions and densities, Markov processes, stationary processes, the law of large numbers, and the central limit theorem. A broad range of applications to communications engineering, economics, biology, and physics.

16:642:593. (F) MATHEMATICAL FOUNDATIONS FOR INDUSTRIAL AND SYSTEMS ENGINEERING (3)
Prerequisite: Permission of instructor.
Underlying mathematical principles of system modeling. Foundations of the real number system and calculus of functions of one variable, with emphasis on logical principles and methods of proof.

16:642:611,612. SELECTED TOPICS IN APPLIED MATHEMATICS (3,3)
Prerequisite: Permission of instructor.
Topics of current interest.

16:642:613. SELECTED MATHEMATICAL TOPICS FROM PHYSIOLOGY AND MEDICINE (3)
Prerequisite: Permission of instructor.
Problems in the qualitative theory of nonlinear ordinary and functional differential equations that arise in such subjects as the Hodgkin-Huxley theory, hormonal control systems, and rhythms in physiology.

16:642:661,662. SELECTED TOPICS IN MATHEMATICAL PHYSICS (3,3)
Prerequisite: Permission of instructor.
Topics of current interest in areas such as classical mechanics, statistical mechanics, ergodic theory, nonrelativistic quantum mechanics, and quantum field theory.

MECHANICAL AND AEROSPACE ENGINEERING 650

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Haim Baruh,**
 B242 Engineering Building, Busch Campus (732/445-3680)
Web Site: *http://mechanical.rutgers.edu/graduate*

Members of the Graduate Faculty

Haim Baruh, *Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Virginia Polytechnic Institute*
 Structural dynamics; control of vibration; smart structures
Haym Benaroya, *Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Pennsylvania*
 Aerospace structures; structural dynamics; probabilistic mechanics; lunar development
William J. Bottega, *Associate Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Yale*
 Composite structures; applied mechanics
David G. Briggs, *Professor Emeritus of Mechanical and Aerospace Engineering, SE; Ph.D., Minnesota*
 Heat transfer; thermodynamics; numerical modeling
Yu Chen, *Professor Emeritus of Mechanics, SE; Sc.D., Harvard*
 Numerical simulation of thermomechanical phenomena; applied mechanics
Alberto Cuitiño, *Associate Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Brown*
 Computational solid mechanics
Mitsunori Denda, *Associate Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Harvard*
 Fracture mechanics; computational solid mechanics
Ellis H. Dill, *University Professor of Mechanical and Aerospace Engineering, SE; Ph.D., California (Berkeley)*
 Continuum mechanics; computational mechanics; finite element methods
Hae Chang Gea, *Associate Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Michigan*
 Design and structural optimization; finite element
Yogesh Jaluria, *Board of Governors Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Cornell*
 Convection; numerical methods in heat transfer; materials processing
Mukund V. Karwe, *Assistant Professor of Food Science, CC; Ph.D., Rutgers*
 Thermal processing of food materials; numerical modeling
Doyle D. Knight, *Professor of Mechanical and Aerospace Engineering, SE; Ph.D., California Institute of Technology*
 Compressible fluid mechanics; turbulence; computational fluid dynamics; auto - mated optimal design; high-performance computing; aerodynamics
Noshir A. Langrana, *Mary W. Reisler Distinguished Chair and Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Cornell*
 Computer-aided design; biomechanics; artificial intelligence in design

Constantinos Mavroidis, *Associate Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Paris VI*
 Analysis and synthesis of mechanisms; design, planning, and control of robotic systems
Michael R. Muller, *Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Brown*
 Fluid mechanics, waves; rotating flows; fluidized beds
Andrew N. Norris, *Chairperson and Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Northwestern*
 Dynamics of solids; wave propagation; mechanics of composite materials
Kook D. Pae, *Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Pennsylvania State*
 Polymer mechanics; high-pressure effects on properties of polymers; surface modification of polymers
Assimina A. Pelegri, *Associate Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Georgia Institute of Technology*
 Fracture mechanics; electromechanical systems; smart structures
Richard L. Peskin, *Professor Emeritus of Mechanical and Aerospace Engineering, SE; Ph.D., Princeton*
 Computational fluid dynamics
Constantine E. Polymeropoulos, *Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Cornell*
 Combustion; heat transfer
Kyung T. Rhee, *Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Wisconsin*
 Internal-combustion engines; flame propagation
Valentinas Sernas, *Professor Emeritus of Mechanical and Aerospace Engineering, SE; Ph.D., Toronto*
 Optical techniques; boiling heat transfer; experimental methods
Samuel Temkin, *Professor Emeritus of Mechanical and Aerospace Engineering, SE; Ph.D., Brown*
 Fluid mechanics; acoustics; droplet dynamics
Stephen D. Tse, *Assistant Professor of Mechanical and Aerospace Engineering, SE; Ph.D., California (Berkeley)*
 Combustion and propulsion, heat and mass transfer, materials synthesis, fire safety
Timothy Wei, *Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Michigan*
 Fluid mechanics and turbulence
George J. Weng, *Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Yale*
 Micromechanics of composite materials; phase transformation
Norman J. Zabusky, *State of New Jersey Professor of Computational Fluid Dynamics, SE; Ph.D., California Institute of Technology*
 Fluid dynamics: computational and analytical; nonlinear dynamical systems
Abdelfattah Zebib, *Deputy Dean and Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Colorado*
 Hydrodynamic stability; computational fluid mechanics
Dajun Zhang, *Assistant Professor of Mechanical and Aerospace Engineering, SE; Ph.D., CUNY*
 Bone mechanics, biophysics, tissue damage mechanics, poroelasticity, experimental mechanics

Programs

Mechanical and aerospace engineering offers graduate programs leading to the master of science and doctor of philosophy degrees.

Individuals wishing to enroll in the M.S. program should have a B.S. degree in mechanical and/or aerospace engineering from an accredited institution and should have graduated with a cumulative grade-point average of 3.0 (where $A = 4.0$) or better. Applicants who have a B.S. degree in other engineering disciplines or in applied mathematics, geology, meteorology, or physics also are considered.

Admission into the Ph.D. program requires an M.S. in mechanical and/or aerospace engineering. Applicants who have an M.S. in a closely related discipline may be admitted directly into the Ph.D. program, provided their preparation has no significant deficiencies. The master of philosophy degree is available to doctoral candidates.

The master of science program is meant to broaden the undergraduate preparation. It can be considered as a terminal degree or may be used as preparation for the Ph.D. program. The M.S. program requires a minimum of 30 credits. Two options are offered: plan A, with thesis; and plan B, without thesis.

The Ph.D. program is intended for those individuals primarily interested in teaching and/or research. It requires a minimum of 48 credits of course work beyond the B.S. degree and a minimum of 24 credits of research beyond the M.S. degree. The program requires successful performance in the Ph.D. qualifying examination, one year of full-time residence, and the completion of a satisfactory

research dissertation. Proficiency in a foreign language is not required. Although a student may attend full time throughout his or her studies, the one-year residence requirement normally is satisfied after the student has passed the qualifying examination. The residency year is devoted mainly to research.

Study is offered in the general areas of applied mechanics and engineering science and design. There are six major fields of study in mechanical and aerospace engineering. These are design and control, fluid mechanics, solid mechanics, structures, materials, and thermal sciences. Because of the exceptional variety and large number of courses available in these areas and because of the wide range of research activities in the program, students have a unique opportunity to acquire a broad and thorough education and training.

Facilities for research include modern laboratories in acoustics, biomechanics, combustion, computational fluid dynamics, computational solid mechanics, heat transfer and thermal convection, computer-aided design, experimental fluid mechanics, internal-combustion engines, optics, and high-pressure mechanics. Engineering Computing Services (ECS), in collaboration with other departments at Rutgers University, operates the Rutgers Computational Grid (RCG)—a state-of-the-art distributed multi-processor (Beowulf) computing facility based on high-performance processors and the Linux operating system. More than 100 processors were installed on the RCG as of September 2000, with additional expansion planned. ECS operates two public workstation laboratories with 70 Sun workstations for instruction and research. ECS provides high-speed network access to the U.S. National Supercomputer Centers sponsored by the National Science Foundation, the Department of Defense, and the Department of Energy. Rutgers operates two 64-processor Sun E10,000 parallel computers located at the Center for Advanced Information Processing (CAIP).

Research areas in which the faculty of the program are engaged include acoustics, applications of artificial intelligence, biomechanics, boiling heat transfer, combustion, composite materials, computational fluid dynamics, computational solid mechanics, control systems, convective heat transfer, delamination mechanics, droplet dynamics, energy management, fracture mechanics, gas dynamics, geophysical fluid dynamics, hydrodynamical instability, internal-combustion engines, incompressible fluid dynamics, kinematics and dynamics of mechanisms, mantle convection, material processing, mechanical design mechanisms, micromechanics, nondestructive evaluation, numerical modeling, optimal design, particulate emission, polymer mechanics, plasticity, random vibration, smart structures, space structures, stability of structures, structural dynamics, thermal-stress analysis, turbulence, turbulent dispersion, and waves in solids.

Degree programs in mechanical and aerospace engineering may be arranged with the graduate program director. Further details may be found on the departmental web site.

Graduate Courses

16:650:500. EXPERIMENTAL METHODS (3)
Prerequisites: Undergraduate fluid mechanics and heat transfer.
Survey of current measuring techniques used in mechanical and aerospace engineering research; principles of digital and analog data acquisition and reduction.

16:650:504,505. MATHEMATICAL METHODS IN ENGINEERING (3,3)
Prerequisites: Undergraduate calculus and differential equations.
Review of matrix algebra; numerical methods for inversion; ordinary differential equations, functions of a complex variable; calculus of variations; partial differential equations and their classification; Fourier methods; asymptotic and perturbation methods.

16:650:510. (F) COMPUTER-AIDED DESIGN (3)
Prerequisite: Permission of instructor.
Broad introduction to computer-aided design and modeling. Mathematical representations of curves, surfaces, and solids. Two- and three-dimensional computer graphics. Programming required for design projects.

16:650:514. DESIGN OF MECHANISMS (3)
Prerequisite: Undergraduate kinematics of mechanisms or equivalent.
Complete mechanism design cycle: synthesis, analysis, and redesign; analytical, numerical, and visualization techniques applied to mechanism synthesis (type, number, and dimensional) and analysis; application of optimization methods in the design cycle; planar and spatial mechanisms.

16:650:518. BIOMECHANICAL SYSTEMS (3)
Prerequisites: Undergraduate mechanical design and solid mechanics.
Selected topics from the study of the human body as a mechanical system, with emphasis on modeling, analysis, and design. Investigation of biomechanical systems in orthopedic surgery and physical rehabilitation.

16:650:522. (S) ANALYTICAL DYNAMICS (3)
Prerequisite: Graduate standing in mechanical/aerospace engineering.
Newtonian mechanics, rotating frames, variational principles, Lagrange's equations, Hamilton's equations, Euler angles, Euler equations, gyroscopic motion.

16:650:530. FLUID MECHANICS I (3)
Prerequisite: Undergraduate fluid mechanics.
Physical properties of fluids; basic equations of motion; kinematics; exact solutions of the Euler and Navier-Stokes equations; incompressible boundary-layer equations and applications; flow past bodies, jets, and wakes; introduction to turbulent flows.

16:650:532. EXPERIMENTAL METHODS IN FLUID MECHANICS (3)
Prerequisite: Undergraduate fluid mechanics.
Experimental and analytical data tools needed by fluid experimentalists, data acquisition, measurements, model building, optical diagnostics, and visualization.

16:650:534. COMPUTATIONAL FLUID MECHANICS (3)
Prerequisites: Undergraduate fluid mechanics and thermodynamics.
Development and application of computational methods for fluid mechanics based on the incompressible and compressible Navier-Stokes equations, boundary-layer equations, and Euler equations. Selected algorithms, including finite difference, finite volume, and special techniques. Applications chosen from incompressible and compressible flows.

16:650:550. MECHANICS OF MATERIALS (3)
Prerequisite: Undergraduate solid mechanics.
Theories and methods for evaluating stresses and deformations of mechanical components and structures under static and dynamic loading.

16:650:554. MECHANICS OF CONTINUA (SOLID MECHANICS I) (3)
Prerequisites: Undergraduate mechanics and engineering mathematics.
Introduction to the fundamental concepts of continuum mechanics, including stress and strain, kinematics, balance laws, and material symmetry. Theories of elasticity, plasticity, fracture, viscoelasticity, and classical fluid dynamics.

16:650:570. CONDUCTION HEAT TRANSFER (3)
Prerequisite: Undergraduate heat transfer.
Analytical methods in steady and transient heat conduction in solids; finite difference methods in heat conduction.

16:650:574. THERMODYNAMIC THEORY (3)
Prerequisite: Undergraduate thermodynamics.
Principles and methods of thermodynamics, including classical, statistical, and irreversible thermodynamics.

16:650:578. CONVECTION HEAT TRANSFER (3)
Prerequisites: Undergraduate heat transfer; 16:650:530 or equivalent.
Forced and free convection in laminar and turbulent flows; mass transfer; applications.

16:650:582. Computational Heat Transfer (3)
Prerequisites: Undergraduate fluid mechanics and thermodynamics.
Development and application of computational methods for conduction; natural, forced, and mixed convection; radiation; traditional and recent conjugate heat transfer; and mass transfer. Selected algorithms include finite difference, finite volume, finite element, and spectral techniques. Applications chosen from thermal energy systems, environmental heat transfer, microelectronics packaging, materials processing, and other areas.

16:650:601,602. Independent Study (3,3)
Prerequisites: Permission of instructor and graduate program director.
Independent studies or investigations in a selected area of mechanical and aerospace engineering. The instructor prepares a syllabus on subject being studied for student's file.

16:650:604. Advanced Engineering Analysis (3)
Prerequisites: 16:642:527; 16:650:522 or 530.
Behavior of linear and nonlinear systems, phase-plane analysis, bifurcation, stability criteria, perturbation methods. Examples from fluid mechanics, dynamics, and heat transfer.

16:650:606. Advanced Mechanical Engineering Topics (3)
Topics of current interest in mechanical and aerospace engineering, such as applications of computer-aided intelligence, computer-aided manufacturing, and waves in fluids.

16:650:608,609. Seminar in Mechanical Engineering (1,1)
Prerequisite: Ph.D. candidacy in mechanical and aerospace engineering or permission of graduate program director.
Lectures by Ph.D. students, faculty, and invited speakers on current research topics in mechanical and aerospace engineering.

16:650:610. Robotics and Mechatronics (3)
Prerequisites: Undergraduate vibrations, controls, dynamics, and statistics.
Introduction to robotics and mechatronics, including mechanisms and control theories as well as applications; manipulator mechanics; design considerations; control fundamentals; model and sensor-based control algorithm development; walking robots; medical and space robotics; experimental mechatronics.

16:650:614. Optimal Design in Mechanical Engineering (3)
Prerequisite: 16:650:550.
Formulation and solution of engineering optimal design problems in mechanical engineering. Introduction to algorithms for constrained and unconstrained searching. Application to optimal design of mechanical and structural components. Use of discretization techniques; shape optimization problem.

16:650:618. Special Applications in Control (3)
Prerequisites: Graduate background in mechanical control systems and vibration.
Introduction to recently developed concepts in control theory and their application in real-life problems. Topics include robust and optimal control (H2, H-infinity, and advanced LQR control techniques), neural networks, and system identification.

16:650:622. Advanced Optimization (3)
Prerequisite: 16:650:614.
Focuses on the mathematical framework of optimization; in-depth coverage of mathematical programming, probabilistic optimization methods, global optimization, and multiobjective optimization and their applications.

16:650:626. Advanced Design and Fabrication (3)
Prerequisites: 16:650:514 and 614, or equivalent.
Synthesis of design methodologies with application to industrial problems.

16:650:630. Fluid Mechanics II (3)
Prerequisite: 16:650:530 or equivalent or permission of instructor.
Vortex dynamics of incompressible inviscid and low-viscosity fluids. One-, two-, and three-dimensional compressible flows. Linear, nonlinear, acoustic, and gravity waves; shock waves using shock polars. Stability of viscous and inviscid vortex, wave and boundary-layer flows. Special topics include accelerated flows: Rayleigh-Taylor and Richtmyer-Meshkov for supersonic combustion and inertial confinement fusion; visualization and quantification of evolving flows; and turbulent scaling laws.

16:650:634. Compressible Flows (3)
Prerequisite: 16:650:630 or equivalent.
Linear and nonlinear theory of one-dimensional inviscid unsteady motion, compression and expansion waves, shock-tube and wave interactions; two-dimensional inviscid steady motions, including linearized subsonic and supersonic flows, boundary-layer theory of compressible fluids.

16:650:636. Turbulence (3)
Prerequisite: 16:650:530.
Physical aspects and methods of analysis of turbulent flows; scaling laws, modeling techniques, and statistical description of turbulence; application to problems in engineering science and geophysical fluid dynamics.

16:650:638. (F) Hydrodynamic Stability (3)
Prerequisite: 16:650:530 or equivalent.
Thermal, centrifugal, and shear instabilities; linear, nonlinear, and energy methods.

16:650:640. Acoustics (3)
Prerequisite: Undergraduate fluid mechanics. Pre- or corequisite: 16:642:530.
Sound-wave propagation in gases and liquids. Reflection and transmission phenomena. Emission and absorption of sound.

16:650:642. Suspensions (3)
Prerequisites: 16:650:530 or equivalent and one graduate-level course in applied mathematics, or consent of instructor.
Fluid mechanics of small bubbles, droplets, and rigid particles in fluids. Fluid forces and heat transfer rate. Two-phase fluid dynamics. Applications to aerosols, bubbly liquids, emulsions, and hydrosols.

16:650:650. Theory of Elasticity (Solid Mechanics II) (3)
Prerequisite: 16:642:527 or equivalent. Corequisite: 16:642:528.
Classical theory of linear elasticity. Equations of equilibrium; plane stress; plane strain; Airy stress function; torsion; energy theorems; solutions of selected classical problems.

16:650:651. Mechanics of Inelastic Behavior (Solid Mechanics III) (3)
Prerequisite: 16:650:550 or 650.
Mechanics of inelastic behavior, including plasticity, viscoelasticity, and micromechanics. Yield criteria, flow and hardening rules, Drucker's postulates, multiaxial theories, and boundary value problems. Rheological models, creep compliances and relaxation moduli, complex moduli, rheologically simple materials. Dislocation theories, crystal plasticity, Eshelby's solution for an inclusion, mechanics of phase transformation.

16:650:652. Composite Materials, Fracture Mechanics, and Thermoelasticity (Solid Mechanics IV) (3)
Prerequisites: 16:650:554, 650.
Composite materials: anisotropy, elastic constants, stress-strain averages, energy principles, bounds, and micromechanics models. Basic principles of fracture mechanics: mechanisms of fracture and crack growth, energy-release rates, complex stress functions, stress intensity, fracture criteria, mixed-mode fracture, dynamic fracture. Thermoelasticity: linear-coupled theory, uncoupled theory, solution of selected applied problems involving heat and deformation, application to composite and advanced materials.

16:650:653. Structural Mechanics (Solid Mechanics V) (3)
Prerequisites: 16:650:550, 554, and 650, or permission of instructor.
Review of plate theory. Foundations of shell theory. Variational calculus and energy theorems, stability and buckling. Composite structures: anisotropic structures, laminated beams, plates and shells, failure mechanisms.

16:650:654. Dynamics of Solids and Structures (Solid Mechanics VI) (3)
Prerequisites: Undergraduate course in mechanical vibration and 16:650:550, 554, and 650.
Review of multidegree of freedom vibration. Vibration of continuous systems: strings, beams, membranes, and plates. Vibration and waves. Waves in beams and plates. Bulk elastic waves. Reflection and transmission, Rayleigh surface waves, ultrasonics. Additional topics, such as random vibration, as time permits.

16:650:660. Computational Solid Mechanics (3)
Prerequisite: 16:650:554.
General theory, application of finite element methods to the solutions of the equations of elasticity, viscoelasticity, and plasticity. Two- and three-dimensional linear and nonlinear, static, and dynamic problems. Working computer programs.

16:650:661. Advanced Mechanical and Random Vibration (3)
Prerequisite: 16:650:654.
Continuous systems, exact and approximate solutions; integral formulation; vibration under combined effects, inclusion principle, qualitative and quantitative behavior of the eigensolution, computational techniques. Random vibration of nonlinear oscillators, Markov processes.

16:650:662. Advanced Stress Waves in Solids (3)
Prerequisite: 16:650:654.
Propagation of elastic waves in solids, reflection and transmission, Rayleigh waves, waves in plates, dispersion, radiation from a point load, Fourier transforms methods; scattering; waves in anisotropic materials; propagation of discontinuities; shocks.

16:650:663. Advanced Plasticity (3)
Prerequisite: 16:650:651.
Advanced theories and computational models in plasticity. Crystal plasticity for metallic systems based on dislocation theory and statistical mechanics. Sources of hardening for single and multiple glide conditions. Nucleation and growth of defects induced by plastic deformation. Large-strain constitutive relations for crystalline materials. Numerical implementation into finite element formulations.

16:650:664. Advanced Fracture Mechanics (3)
Prerequisite: 16:650:652.
Fracture mechanics; linear elastic, dynamic, and elastic-plastic methods and structures. Time dependent fracture and fatigue crack growth for metals, ceramics, polymers, and composites. Mathematical methods in fracture mechanics; weight functions (3D), Green's functions (dislocation and point force), complex variable methods (2D), integral transforms, and applications of the FEM and BEM.

16:650:665. Advanced Composite Materials (3)
Prerequisite: 16:650:650.
Classification of anisotropy; elastic constants; particulate, fiber, and disc reinforcements; stress-strain average and energy principles; mean-field theory; self-consistent method; differential scheme; Hashin-Shtrikman's variational principles; bounding techniques; and viscoelastic, plastic, and viscoplastic composites.

16:650:666. Advanced Micromechanics (3)
Prerequisite: 16:650:650 or 651.
Origins of internal stress, Green's tensor function. Eshelby's solutions of ellipsoidal inclusions, stress concentration; crystal plasticity; continuous distribution of dislocations; single crystal versus polycrystal; Martensitic transformation in shape-memory alloys, ferroelectric ceramics.

16:650:667. Advanced Stability of Elastic Systems (3)
Prerequisites: 16:650:554 and 650, 16:642:528.
Hamilton's principle; discrete and continuous systems; dynamical theories of beams and plates; nonlinear vibrations; Liapunov stability; limit cycles; chaotic motion. Applications include the static and dynamic stability of thin-walled structures.

16:650:668. Advanced Viscoelasticity (3)
Prerequisite: 16:650:651.
Basic rheological models and differential constitutive equations; Boltzman's superposition principle and hereditary integrals, Laplace transform; creep, relaxation, and complex moduli; discrete and continuous spectra; thermorheologically simple materials; glass transition temperature; William-Landel-Ferry (WLF) equation; chronorheologically simple and rheological complex materials; physical aging.

16:650:669. Advanced Thermoelasticity (3)
Prerequisite: 16:650:652.
Formulation and solution of problems involving the effects of temperature on the elastic and inelastic behavior of materials and structures. Thermodynamics of deformation; heat transfer; thermoelasticity/thermoviscoelasticity.

16:650:670. Combustion (3)
Prerequisites: Undergraduate thermodynamics and fluid mechanics.
Fundamentals of combustion processes; premixed flames, diffusion flames, one-dimensional gas dynamics, thermal explosion theory.

16:650:674. Radiation Heat Transfer (3)
Prerequisite: Undergraduate heat transfer.
Theory of radiant heat transfer; characteristics of ideal and real systems; radiant energy exchange with and without a participating medium; analytical numerical experimental techniques; gray and nongray system analysis.

16:650:678. Boiling and Condensation Heat Transfer (3)
Prerequisites: Undergraduate heat transfer and fluid mechanics.
Detailed presentation of boiling and condensation heat transfer; nucleate boiling, transitional boiling, film boiling, film condensation, and dropwise condensation.

16:650:682. Thermal Transport in Materials Processing (3)
Prerequisites: Limited enrollment, permission of instructor.
Transport phenomena in processes such as heat treatment, bonding, extrusion, casting, injection molding, crystal growing, metal forming, and plastic processing; analysis, mathematical modeling, and numerical simulation of such processes for design and optimization of the relevant systems.

16:650:699. Nonthesis Study (N1)

16:650:701,702. Research in Mechanical and Aerospace Engineering (BA,BA)
By arrangement with adviser.

MECHANICS 654

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Bernard D. Coleman,**
  B134 Engineering Building, Busch Campus (732/445-5558)

Members of the Graduate Faculty

Haim Brezis, *Visiting Distinguished Professor of Mathematics, FAS–NB; Doctorat, Paris*
  Nonlinear functional analysis; partial differential equations
Bernard D. Coleman, *J. Willard Gibbs Professor of Thermomechanics, SE; Ph.D., Yale*
  Continuum physics; mathematical analysis; constitutive theory; thermodynamics; rheology; liquid-crystal physics
Ellis H. Dill, *University Professor of Mechanical and Aerospace Engineering, SE; Ph.D., California (Berkeley)*
  Continuum mechanics; computational mechanics; finite element methods

Richard S. Falk, *Professor of Mathematics, FAS–NB; Ph.D., Cornell*
Numerical analysis of problems in elasticity; partial differential equations
Wilma K. Olson, *Mary I. Bunting Professor of Chemistry, FAS–NB;*
Ph.D., Stanford
Theoretical studies of nucleic acid structure and properties
Irwin Tobias, *Professor Emeritus of Chemistry, FAS–NB; Ph.D., Princeton*
Continuum models of biological macromolecules; mechanics of supercoiling
in DNA
Michael Vogelius, *Professor of Mathematics, FAS–NB; Ph.D., Maryland*
Numerical analysis; partial differential equations

Programs

The graduate program in mechanics offers advanced instruction
and research in theoretical mechanics. The broad areas of study
are continuum mechanics, thermodynamics, analytical dynamics,
and their applications to problems in engineering, materials science,
and molecular biology. The topics of courses, seminars, and research
include elasticity, viscoelasticity, the theory of non-Newtonian fluids,
liquid-crystal theory, the mechanics and thermodynamics of phase
transformations, and the development of the elastic rod model
for DNA. Students also can explore modern constitutive theory
(e.g., invariance principles, thermodynamic relations, and
homogenization theory).

Excellent computational facilities are available to students,
including a variety of workstations and access to supercomputers.

Students applying to the M.S. and Ph.D. programs should have
a B.S. or B.A. degree in engineering, mathematics, or the physical
sciences. The M.S. degree requires 30 credits and either a critical
essay or a research thesis. The requirements for the Ph.D. degree
include an appropriate combination of course work and research
credits, a qualifying examination, and a dissertation. The qualifying
examination is given in two parts, written and oral. Students are
required to attend and participate in the mechanics seminar series.
Candidates for the Ph.D. degree will be expected to spend at least
one year in full-time residence, a requirement that will be waived
only in exceptional circumstances.

Several fellowships are available to first-year and advanced
students. Students receiving fellowships are expected to devote
their full time to course work and research. Teaching assistantships
and research assistantships associated with specific research proj-
ects may be available. Further information about these and other
matters may be found at the *Graduate Program in Mechanics*
web site, *http://mechanics.rutgers.edu*.

Graduate Courses

16:654:543. (S) CONTINUUM MECHANICS (3)
Coleman. Prerequisite: 16:650:554 or permission of instructor.
Algebraic and geometric methods in continuum physics; kine-
matical concepts, balance of momentum; introduction to the
general theory of constitutive relations, material symmetry, and
frame-indifference. Examples of nonlinear theories of material
behavior (e.g., finite elasticity, non-Newtonian fluids, materials
with memory).

16:654:545. (S) CONTINUUM THERMODYNAMICS (3)
Coleman. Prerequisite: 16:654:543 or permission of instructor.
Theory of thermodynamical restrictions on the constitutive rela-
tions of viscous materials, materials with memory, and materials
with internal state variables. Energy criteria for stability; thermal
influences on wave propagation; thermodynamical methods in the
theory of the field equations of mechanics.

16:654:583. ADVANCED THEORY OF ELASTICITY (3)
Prerequisites: Elasticity, e.g., 16:650:604, and continuum mechanics,
e.g., 16:654:543.
Advanced topics in the linear theory of elasticity and an introduction
to finite elasticity. Uniqueness and stability theorems; variational
principles; theories of rods, plates, and shells.

16:654:601,602. SELECTED TOPICS IN CONTINUUM MECHANICS (3,3)
Prerequisite: Permission of instructor.
Topics of current interest in such areas as constitutive theory, finite
elasticity, viscoelasticity, theory of liquid crystals.

16:654:603,604. SELECTED TOPICS IN COMPUTATIONAL
MECHANICS (3,3)
Prerequisite: Permission of instructor.
Topics of current interest in the theory and application of numerical
methods to the solution of problems in such subjects as elasticity,
the mechanics of rods and shells, plasticity, the theory of materials
with memory, and the theory of liquid crystal phases.

16:654:605,606. SELECTED TOPICS IN PHASE TRANSFORMATION
THEORY (3,3)
Prerequisite: Permission of instructor.
Topics of current interest in such subjects as heterogeneous equilib-
rium, the dynamics of phase transitions, spinodal decomposition,
and interface motion.

16:654:611,612. SEMINAR IN MECHANICS (1,1)
Faculty, students, and invited speakers participate in presentations
of contemporary topics in mechanics and related branches of math-
ematics and numerical analysis.

16:654:701,702. RESEARCH IN MECHANICS (BA,BA)

MEDICINAL CHEMISTRY 663

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Joseph E. Rice, Ernest Mario**
School of Pharmacy, William Levine Hall, Busch Campus
(732/445-5381)

Members of the Graduate Faculty

Edward Arnold, *Professor of Chemistry, FAS–NB, Ph.D., Cornell*
Antiviral drug design, molecular recognition, X-ray crystallography
Leonard C. Bailey, *Professor Emeritus of Chemistry, EMSP; Ph.D., Rutgers*
Pharmaceutical analysis
Chi-Tang Ho, *Professor of Food Science, CC; Ph.D., Washington,*
Separation and structural elucidation of bioactive compounds in food, spices,
and herbs
Lonquin Hu, *Assistant Professor of Medicinal Chemistry, EMSP; Ph.D., Kansas*
Design and synthesis of enzyme inhibitors and peptidomimetics, prodrugs
Leslie Jimenez, *Associate Professor of Chemistry, FAS–NB; Ph.D.,*
California (Los Angeles)
Natural product synthesis and new synthetic methodology
John E. Kerrigan, *Adjunct Associate Professor of Pharmacology,*
UMDNJ–RWJMS; Ph.D., Georgia Institute of Technology
Serine protease inhibitors, molecular modeling, and computational chemistry
Edmund J. LaVoie, *Chairperson and Professor of Medicinal Chemistry,*
EMSP; Ph.D., SUNY (Buffalo)
Metabolism and structure-activity studies of pharmacological agents
Thomas Medwick, *Professor Emeritus of Pharmaceutical Chemistry,*
EMSP; Ph.D., Wisconsin
Pharmaceutical analysis
Joseph E., Rice, *Associate Professor of Medicinal Chemistry,*
EMSP; Ph.D., Polytechnic Institute of New York
Synthetic organ chemistry as applied to problems of biological interest
Robert T. Rosen, *Associate Director, CAFT, CC; Ph.D., Rutgers*
Analytical and natural products chemistry
James E. Simon, *Professor of New Use Agriculture, CC; Ph.D.,*
Massachusetts (Amherst)
Plant-derived natural products with medicinal activity
William E. Welsh, *Professor of Pharmacology and Director, UMDNJ Informatics*
Institute, UMDNJ–RWJMS; Ph.D., Pennsylvania
Computer-aided molecular modeling and design, bioinformatics, cheminformatics

Associate Member of the Graduate Faculty

S. David Kimball, *Senior Director, Medicinal Chemistry, Lexicon Pharmaceuticals;*
Ph.D., SUNY (Stony Brook)
Inhibition of cyclin-dependent kinases; discovery of mechanism-based
anticancer drugs

Programs

Courses of study leading to the master of science and doctor of
philosophy degrees in medicinal chemistry are offered. Most appli-
cants have undergraduate degrees in chemistry, biochemistry,
biology, pharmacy, or other physical or biological sciences. It is
strongly recommended that applicants have completed 6 credits
of physical chemistry prior to admission. Areas of research in

medicinal chemistry include drug discovery, natural product synthesis, prodrugs, peptidomimetics, enzyme inhibitors, computational chemistry, molecular modeling and natural product isolation, and structure elucidation.

Degree requirements for the M.S. include a minimum of 25 credits of course work and completion of an original research problem and thesis (6 credits).

The Ph.D. requirements include a minimum of 38 credits of course work and 34 credits of research in medicinal chemistry. All students are required to prepare and defend an original research proposal. A residence requirement of one academic year must also be satisfied, preferably after completion of most of the required course work.

For a more detailed account of degree requirements, courses, facilities, faculty research interests, and application procedures, please visit the Department of Medicinal Chemistry home page at *http://www.rci.rutgers.edu/~layla/index_home.html.*

Graduate Courses

16:663:501. MEDICINAL CHEMISTRY: RESEARCH TECHNIQUES AND PRINCIPLES (3)
Rice, Kimball. Prerequisite: 01:160:305, 306, or equivalent.
Basic course for students preparing to do research in medicinal chemistry. Information management, computer methods, basic laboratory techniques, principles of medicinal chemistry, and quantitative structure-activity relationships.

16:663:502. PRINCIPLES OF DRUG DESIGN (3)
Hu, Kerrigan. Prerequisite: 16:160:305, 306, or equivalent.
Identifying new drug leads, drug absorption and distribution, pharmacomodulation, enzymes and receptors as targets, peptidomimetics, computer-aided drug design, and combinatorial chemistry.

16:663:504. STRATEGIES AND TACTICS IN SYNTHETIC MEDICINAL CHEMISTRY (3)
Rice. Prerequisite: 16:160:503 or equivalent.
Design of syntheses for complex organic medicinal agents. Preparation of series of analogs for structure-activity investigations.

16:663:505. DRUGS: STRUCTURE AND FUNCTION (3)
LaVoie, Rice. Prerequisites: 01:160:305, 306, or equivalent.
Design of syntheses for complex organic medicinal agents. Preparation of series of analogs for structure-activity investigations.

16:663:508. LABORATORY ROTATION IN MEDICINAL CHEMISTRY (3)
Restricted to first-year graduate students.
Students gain familiarity with the instrumentation and research facilities of the department by participating in research projects in the laboratories of two or three faculty members.

16:663:540. INDEPENDENT RESEARCH PROPOSAL (3)
The student must prepare a research proposal (NIH format) on a topic not directly related to his/her research project. Following completion of the written proposal, the student is required to defend the proposal to his/her dissertation committee.

16:663:601,602. SEMINAR IN MEDICINAL CHEMISTRY (3,3)
Students prepare and present a discussion of a recent topic in medicinal chemistry.

16:663:607,608. SPECIAL TOPICS IN MEDICINAL CHEMISTRY (3,3)
Selected topics in medicinal chemistry.

16:663:610,611. INDEPENDENT STUDY IN MEDICINAL CHEMISTRY (3)
No more than 3 credits may be taken as part of a student's program. Independent library research into special topics in medicinal chemistry; arranged under the supervision of a faculty member.

16:663:612,613. CURRENT TOPICS IN MEDICINAL CHEMISTRY (3,3)
Selected current topics in medicinal chemistry presented in seminar format.

16:663:701,702. RESEARCH IN MEDICINAL CHEMISTRY (3,3)
Thesis or dissertation in medicinal chemistry under the supervision of a faculty member.

MEDIEVAL STUDIES 667

Program Offered: **Certificate in Medieval Studies**
Director of the Certificate Program in Medieval Studies:
Professor James Masschaele, Medieval Studies Program, Department of History, Room 002A, Van Dyck Hall, College Avenue Campus (732/932-6705; fax: 732/932-6763)

Participating Faculty

The following members of the graduate faculty are among those in charge of the curricular arrangements for a certificate program in medieval studies as part of a wider advanced-degree program:

P. Bathory, *Political Science*
R. Bell, *History*
C. Chism, *Literatures in English*
M. Ciklamini, *German*
F. Cornilliat, *French*
L. Edmunds, *Classics*
M. Gossy, *Spanish*
F. Grave, *Music*
C. Guardiola, *Spanish*
A. Harvey, *Art History*
S. Kelly, *History*
A. Kirkman, *Music*
S. Klein, *Literatures in English*
D. Marsh, *Italian*
J. Masschaele, *History*
J. Miller, *Literatures in English*
K. Morrison, *History*
D. Otero-Torres, *Spanish*
A. Pairet, *French*
S. Reinert, *History*
L. Scanlon, *Literatures in English*
M. Speer, *French*
S. Takács, *Classics*
A. Vettori, *Italian*
A. Welsh, *Literatures in English*
L. White, *Italian*

Certificate Program

Students with a special interest in medieval studies may pursue, in the course of their regular advanced-degree program, a special concentration in medieval studies. Those who fulfill the requirements may be awarded a certificate in medieval studies upon completion of their degrees.

Students may use many of the requirements for the certificate to satisfy their own graduate-degree requirements. To gain admittance to the certificate program, a student must

1. take at least two courses in a medieval subject within the chosen discipline with no grade lower than *B,*
2. complete at least three other courses in a medieval culture in other disciplines with no grade lower than *B,*
3. demonstrate a reading knowledge of at least two languages in the forms common during the Middle Ages,
4. submit a completed master's thesis, a doctoral thesis, or an expanded seminar paper on a topic in medieval civilization.

The various courses in medieval studies are offered by the participating faculty and additional faculty through their departments. A list of such courses is available from the director.

Graduate Courses

16:667:501,502. MEDIEVAL LATIN (3,3)
Prerequisites: Two terms of classical Latin.
An overview of medieval Latin; grammar and syntax followed by readings in major texts, including works in theology, philosophy, and literature.

16:667:550,551. MEDIEVAL PALEOGRAPHY (3,3)
Introduction to the study of manuscripts, records, and the manuscript book.

16:667:602. ADVANCED TOPICS IN MEDIEVAL STUDIES (3)
Seminar of interdisciplinary scope.

METEOROLOGY
(See Environmental Sciences 375)

MICROBIOLOGY AND MOLECULAR GENETICS 681

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Andrew K. Vershon,**
  Nelson Biology Laboratories, Busch Campus (732/445-5086)

Members of the Graduate Faculty

Morad A. Abou-Sabé, *Associate Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Pittsburgh*
Microbial genetics; gene expression

Alan D. Antoine, *Associate Professor of Microbiology, CC; D.Sc., Johns Hopkins*
Microbial biochemistry and physiology; metabolism of nitroaromatic compounds; biochemistry and taxonomic classification of cyanobacteria

Edward Arnold, *Professor of Chemistry, FAS–NB/CABM; Ph.D., Cornell*
Protein and virus structure; crystallography; AIDS; polymerases; drug and vaccine design

David E. Axelrod, *Professor of Genetics, FAS–NB; Ph.D., Tennessee*
Cellular and molecular oncology; tumor-cell proliferation

Tamar Barkay, *Associate Professor of Biochemistry and Microbiology, CC; Ph.D., Maryland*
Microbial ecology of the interactions of microbes with toxic metals

Helen M. Berman, *Professor of Chemistry, FAS–NB; Ph.D., Pittsburgh*
Nucleic acid and protein structure; crystallography; biological databases

Gary Brewer, *Associate Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; Ph.D., Vanderbilt*
Gene expression in cancer, immunity, and heart disease

Steven J. Brill, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., SUNY (Stony Brook)*
Biochemistry and genetics of DNA replication in yeast

Linda Brzustowicz, *Associate Professor of Genetics, FAS–NB; M.D., Columbia*
Human molecular genetics, genetics of psychiatric disorders

George M. Carman, *Professor of Food Science, CC; Ph.D., Massachusetts*
Molecular biology of phospholipid biosynthesis in yeast

Kiran K. Chada, *Professor of Biochemistry, UMDNJ–RWJMS; Ph.D., Oxford*
Functional genomics in cancer and disease

Theodore Chase, Jr., *Professor and Chairperson of Biochemistry and Microbiology, CC; Ph.D., California (Berkeley)*
Microbial biochemistry in the environment; plant enzymology and molecular biology of ripening and flavor

Suzie Chen, *Associate Professor of Chemical Biology, EMSP; Ph.D., Albert Einstein*
Transgenic mice predisposed to melanoma development; molecular mechanisms of adipocyte differentiation; UV-inducible genes

Xuemei Chen, *Assistant Professor of Genetics, WIM/FAS–NB; Ph.D., Cornell*
Molecular genetic analysis of flower development in **Arabidopsis**

Khew-Voon Chin, *Assistant Professor of Medicine and Pharmacology, CINJ/UMDNJ–RWJMS; Ph.D., Rutgers*
Drug resistance in cancers; regulation of gene expression

Lori Ruth Covey, *Associate Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Columbia*
Switch recombination in human B lymphocytes in response to T cell factors

Kiron M. Das, *Professor of Medicine, Microbiology, and Molecular Genetics, UMDNJ–RWJMS; Ph.D., Edinburgh; M.D., Calcutta*
Autoimmunity in inflammatory-bowel diseases

David T. Denhardt, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., California Institute of Technology*
Molecular biology of cancer; cell signaling and regulation of gene expression; structure and function of osteopontin and tissue inhibitor or metalloproteinases

Hugo K. Dooner, *Professor of Plant Science, CC/WIM; Ph.D., Wisconsin*
Plant molecular genetics; transposons; meiotic recombination; functional genomics

Joseph P. Dougherty, *Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; Ph.D., Yale*
Retrovirus replication and gene theory

Monica Driscoll, *Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Harvard*
C. elegans *developmental genetics; molecular mechanisms of inherited neurodegeneration*

Donald T. Dubin, *Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; M.D., Columbia*
Evolution of antibiotic resistance in bacteria

Richard H. Ebright, *Howard Hughes Medical Institute Professor of Chemistry, WIM; Ph.D., Harvard*
Transcription; protein-DNAinteraction; protein-protein interaction; single-molecule imaging

Isaac Edery, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB/CABM; Ph.D., McGill*
Molecular mechanism underlying biological clocks

Douglas E. Eveleigh, *Professor of Microbiology, CC; Ph.D., Exeter*
Applied microbiology: fermentation, organic chemicals from biomass; cellulose transformation; microbial ecology

Martin Farach-Colton, *Associate Professor of Computer Science, FAS–NB; M.D., Johns Hopkins; Ph.D., Maryland*
Computational biology; design and analysis of sequential and parallel algorithms

Joseph Fondell, *Assistant Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., SUNY (Stony Brook)*
Regulation of gene expression by nuclear hormone receptors

Dunne Fong, *Associate Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Princeton*
Immunology and molecular cell biology of parasitic protozoans

David J. Foran, *Assistant Professor of Pathology, UMDNJ–RWJMS; Ph.D., Rutgers/UMDNJ*
Imaging; telemedicine; bioinformatics; pattern recognition; computer-assisted diagnosis

Abram Gabriel, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB/CABM; M.D., Johns Hopkins*
Mechanisms of retrotransposon replication; chromosomal rearrangements

Marc R. Gartenberg, *Associate Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Yale*
Chromatin structure, gene regulation, and epigenetic inheritance in yeast

Celine Gelinas, *Professor of Biochemistry, UMDNJ–RWJMS/CABM; Ph.D., Sherbrooke*
Function of viral and cellular oncogenes

Barth Grant, *Assistant Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Princeton*
Molecular mechanisms regulating endocytosis and endocytic recycling in **C. elegans** *and mammals*

Max Haggblom, *Professor of Biochemistry and Microbiology, CC/BCAE; Ph.D., Helsinki*
Environmental and applied microbiology; bioremediation; microbial physiology

Beatrice Haimovich, *Associate Professor of Surgery, UMDNJ–RWJMS; Ph.D., Pennsylvania*
Adhesion receptors mediated signals that regulate cell adhesion and spreading

Jody Hey, *Professor of Genetics, FAS–NB; Ph.D., SUNY (Stony Brook)*
Evolution, speciation, human origins, recombination, natural selection, codon bias

Sarah Hitchcock-DeGregori, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS; Ph.D., Case Western Reserve*
Structure-function relationships in contractile proteins; folding and design of coiled-coil proteins

Masayori Inouye, *Professor and Chairperson of Biochemistry and Molecular Biology, UMDNJ–RWJMS; Ph.D., Osaka*
Signal transduction; adaptation to stresses; protein folding

Ken Irvine, *Howard Hughes Medical Institute Associate Professor of Molecular Biology and Biochemistry, FAS–NB/WIM; Ph.D., Stanford*
Cell communication, patterning, and morphogenesis

Peter C. Kahn, *Associate Professor of Biochemistry, CC; Ph.D., Columbia*
Protein folding and assembly; modeling; hydration in biological systems

Stanley E. Katz, *Professor of Microbiology, CC; Ph.D., Rutgers*
Analytical and environmental microbiology; transformation of organic molecules; antibiotics in animal products

Lee Kerkhof, *Assistant Professor of Marine and Coastal Sciences, CC/IMCS; Ph.D., California (San Diego)*
Marine microbiology, molecular ecology, microbial population dynamics

Randall Kerstetter, *Assistant Professor of Plant Biology and Pathology, FAS–NB/WIM; Ph.D., California (Berkeley)*
Molecular genetics of leaf development and morphogenesis using model plant system

Terri Goss Kinzy, *Associate Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; Ph.D., Case Western Reserve*
Eukaryotic translation elongation and regulation of gene expression

Tony Ah-Ng Kong, *Professor of Pharmaceutics, EOHSI/EMSP; Ph.D., SUNY (Buffalo)*
Map kinases and caspases signaling in cell life and cell death, Nrf2 transcription factor, cancer chemopreventitive compounds and environmental agents

Jerome J. Kukor, *Associate Professor of Environmental Sciences, CC; Ph.D., Michigan*
Biochemistry and genetics of microorganisms involved in biodegradation

Casimir A. Kulikowski, *Professor of Computer Science, FAS–NB; Ph.D., Hawaii*
Intelligent systems and machine learning in molecular biology

Eric Lam, *Professor of Plant Sciences, BCAE/CC; Ph.D., California (Berkeley)*
Plant gene targeting; programmed cell death; chromatin imaging

Jerome A. Langer, *Associate Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; Ph.D., Yale*
Cloning and ligand interactions of the cell surface receptor for alpha interferon

Edmund Lattime, *Professor of Surgery, UMDNJ–RWJMS/CINJ; Ph.D., Rutgers*
Tumor immunology, immune mechanisms, genetically based vaccine strategies

Michael Lawton, *Associate Professor of Plant Science, CC/BCAE; Ph.D., Oxford*
Plant defense responses, signal transduction

Michael J. Leibowitz, *Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; M.D., Ph.D., Yeshiva*
Host-virus interactions in yeast; molecular epidemiology; ribozyme enzymology; HIV regulatory proteins

John Lenard, *Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., Cornell*
RNA virus structure, fusion cellular entry, transcription and assembly

Thomas Leustek, *Professor of Plant Science, CC/BCAE; Ph.D., Rutgers*
Plant biochemistry; molecular biology; cysteine and methionine biosynthesis and metabolism; sulfur assimilation; general metabolism

Ronald M. Levy, *Professor of Chemistry, FAS–NB; Ph.D., Harvard*
Computational molecular biology; computational chemistry; computer modeling of protein structure; folding and dynamics; structural genomics

Alice Y.-C. Liu, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Mount Sinai*
Signal transduction mechanism of the heat-shock response; heat-shock gene expression and cell aging

Peter Lobel, *Professor of Pharmacology, UMDNJ–RWJMS/CABM; Ph.D., Columbia*
Lysomal enzymes and human hereditary diseases, mannose 6-phosphate receptors

Kiran Madura, *Associate Professor of Biochemistry, UMDNJ–RWJMS; Ph.D., Rochester*
Mechanism and significance of ubiquitin-mediated proteolysis in DNA repair and signal transduction

Pal Maliga, *Professor of Plant Science, FAS–NB/WIM; Ph.D., Hungarian Academy of Sciences*
Plastid genetics and development; RNA editing

Richard A. Mann, *Associate Professor of Medicine, UMDNJ–RWJMS; M.D., Yeshiva (Einstein)*
Immunopathogenesis of renal disease

Charles E. Martin, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Florida State*
Genetic regulation of membrane lipid biosynthesis in **Saccharomyces**

Tara Matise, *Associate Professor of Genetics, FAS–NB; Ph.D., Pittsburgh*
Computational genetics, genome bioinformatics, linkage analysis of complex traits

Karl Matthews, *Assistant Professor of Food Science, CC; Ph.D., Kentucky*
Genetics understanding of virulence and survival mechanisms of foodborne pathogens

Kim S. McKim, *Associate Professor of Genetics, FAS–NB/WIM; Ph.D., British Columbia*
Regulation of meiotic recombination; homologous chromosome pairing; DNA repair

Joachim W. Messing, *University Professor of Molecular Biology and Director of the Waksman Institute of Microbiology, FAS–NB/WIM; Ph.D., Munich*
Molecular biology of higher plants; M13 cloning, sequencing, gene synthesis

James Millonig, *Assistant Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS/CABM; Ph.D., Princeton*
Dorsal CNS development, Bmp signaling, mouse mutations, and autism

Gaetano T. Montelione, *Professor of Molecular Biology and Biochemistry, FAS–NB/CABM; Ph.D., Cornell*
Protein structure and dynamics; NMR spectroscopy; structural bioinformatics

Thomas J. Montville, *Professor of Food Science, CC; Ph.D., Massachusetts Institute of Technology*
Metabolic regulation of foodborne microbes; novel antimicrobials

N. Ronald Morris, *Professor of Pharmacology, UMDNJ–RWJMS; M.D., Yale*
Molecular biology of mitosis and microtubules

William R. Moyle, *Professor of Obstetrics and Gynecology, UMDNJ–RWJMS; Ph.D., Harvard*
Structure and function of glycoprotein hormones and their receptors

Joseph I. Naus, *Professor of Statistics, FAS–NB; Ph.D., Harvard*
Significance of matching in DNA sequences; scan-statistic probabilities of clustering; data editing

Robert A. Niederman, *Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Illinois*
Structure, function, and assembly of energy-transducing membranes

Wilma K. Olson, *Mary I. Bunting Professor of Chemistry, FAS–NB; Ph.D., Stanford*
Theoretical studies of nucleic acid structure and properties; relation of structure, conformation, and function of nucleic acids

Richard Padgett, *Professor of Molecular Biology and Biochemistry, WIM/FAS–NB; Ph.D., North Carolina*
TGF beta signal transduction in **C. elegans** *and* **Drosophila**

Nicola Partridge, *Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., Western Australia*
Signal transduction, transcriptional regulation, metalloproteinases

Howard C. Passmore, Jr., *Professor of Microbiology and Molecular Genetics, FAS–NB; Ph.D., Michigan*
Regulation of meiotic recombination; mouse models for the expression of tumor suppressor genes

Henrik Pedersen, *Professor of Chemical and Biochemical Engineering, SE; Ph.D., Yale*
Plant cell culture; biosensing

Stuart W. Peltz, *Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; Ph.D., Wisconsin (Madison)*
Eukaryote gene expression

Sidney Pestka, *Professor and Chairperson of Molecular Genetics and Microbiology, UMDNJ–RWJMS; M.D., Pennsylvania*
Interferons and cytokine receptors; signal transduction

John Pintar, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS/CABM; Ph.D., Oregon*
Insulin-like growth factors in early mammalian development, pituitary development

Ronald D. Poretz, *Professor of Biochemistry and Microbiology, CC; Ph.D., SUNY (Buffalo)*
Inherited susceptibility to neurotoxicants; intracellular targeting of drugs; endo-cytosis glycoconjugate glycans

David Pramer, *Professor Emeritus of Microbiology, CC; Ph.D., Rutgers*
Biological control; biodegradation of natural and manufactured compounds; nematode-trapping fungi

Carl A. Price, *Professor Emeritus of Genetics, FAS–NB; Ph.D., Harvard*
Plant molecular biology; regulation of gene expression in plastids

Arnold B. Rabson, *Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; M.D., Brown*
Molecular biology of human retroviruses; gene regulation in human cancer

Joseph Ramos, *Assistant Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Virginia*
Cell signaling, integrins, cell adhesion, and cancer

Karel Raska, Jr., *Professor of Pathology, Molecular Genetics, and Microbiology, UMDNJ–RWJMS, and Chairperson of Laboratory Medicine and Pathology, UMDNJ–NJMS; M.D., Charles; Ph.D., Czechoslovak Academy of Sciences*
DNA tumor viruses; immunopathology and molecular mechanisms in human cancers

Yacov Ron, *Associate Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; Ph.D., Weizmann Institute of Science*
Autoimmunity; development of B and T cells; gene therapy

Monica Roth, *Professor of Biochemistry, UMDNJ–RWJMS; Ph.D., Einstein*
Retroviruses, integration, reverse transcriptase, Rnase, envelope proteins

Amrik Sahota, *Research Professor of Genetics, FAS–NB; Ph.D., London*
Human inherited diseases and molecular diagnosis

Marilyn M. Sanders, *Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Washington*
DNA topoisomerases as antifungal and antiprotozoan drug targets; the heat shock response in eukaryotic cells

Carl P. Schaffner, *Professor Emeritus of Microbial Chemistry, WIM; Ph.D., Illinois*
Chemical and biological properties of microbial products

Donald W. Schaffner, *Associate Extension Specialist in Food Science, CC; Ph.D., Georgia*
Food microbiology

Konstantin Severinov, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB/WIM; Ph.D., Russian Academy of Sciences*
Structure and function of RNA polymerases from eubacteria and yeasts

Aaron J. Shatkin, *Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; University Professor of Molecular Biology, FAS–NB; Director of the Center for Advanced Biotechnology and Medicine; Ph.D., Rockefeller*
Eukaryotic gene expression; viral cytopathogenesis

Leonard H. Sigal, *Professor of Medicine, UMDNJ–RWJMS; M.D., Stanford*
Immunopathogenesis of Lyme neurologic disease; cross-reactions between human axonal protein and flagellin of Borrelia burgdorferi

Lee D. Simon, *Associate Professor of Genetics, FAS–NB/CC; Ph.D., Rochester*
Molecular biology of protein degradation in prokaryotes

Andrew Singson, *Assistant Professor of Genetics, FAS–NB/WIM; Ph.D., California (San Diego)*
Reproductive biology and cell-cell interactions in **C. elegans**

Navin K. Sinha, *Associate Professor of Genetics, FAS–NB/WIM; Ph.D., Minnesota*
Mechanisms of spontaneous and induced mutations

Peter Smouse, *Professor of Ecology and Evolution, CC/BCAE; Ph.D., North Carolina State*
Mathematical representation of molecular phylogenics

William Sofer, *Professor of Genetics, FAS–NB/WIM; Ph.D., Miami*
Genetic algorithms for predicting secondary structure of proteins

Stanley Stein, *Professor of Molecular Biology, CABM/UMDNJ–RWJMS; Ph.D., CUNY*
Protein analysis; synthesis of peptides and antisense DNA

Ruth Steward, *Professor of Molecular Biology and Biochemistry, WIM/FAS–NB; Ph.D., Basel*
NF-KB signaling; establishment of embryonic polarity; nuclear migration and RNA transport in **Drosophila**

Ann C. St. John, *Associate Professor of Genetics, FAS–NB; Ph.D., Wisconsin (Madison)*
Regulation of protein catabolism; stress-response proteins

Victor Stollar, *Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; M.D.C.M., Queen's (Ontario)*
Viral replication in mammalian and insect cells

Roger Strair, *Associate Professor of Medicine, CINJ/UMDNJ–RWJMS; M.D., Ph.D., Albert Einstein*
Hemotopoietic malignancies; stem-cell transplantation

Thresia Thomas, *Associate Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Indian Institute of Science (Bangalore)*
Molecular biology of breast cancer: polyamines, estradiol, and cyclins

Moti L. Tiku, *Associate Professor of Medicine, UMDNJ–RWJMS; M.D., Delhi*
Immunobiology of autoimmune diseases; rheumatoid and osteoarthritis; immunology and cytokine biology; reactive oxygen radicals and aging

Jay Tischfield, *Professor and Chair of Genetics, FAS–NB; Ph.D., Yale*
Gene regulation, human genetic diseases

Robert Trelstad, *Professor of Pathology and Laboratory Medicine, UMDNJ–RWJMS; M.D., Harvard*
Matrix morphogenesis and macromolecular patterning

Nilgun E. Tumer, *Professor of Plant Pathology, BCAE/CC; Ph.D., Purdue*
Mechanisms of virus resistance, mechanism of antiviral action of ribosome inacti - vating proteins, turfgrass transformation and improvement

Aurea C. Vasconcelos, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Chicago*
Cell biology; plant molecular biology; chloroplast development, function, and reg - ulation; carbohydrate metabolism in plants

Andrew K. Vershon, *Professor of Molecular Biology and Biochemistry, WIM/FAS–NB; Ph.D., Massachusetts Institute of Technology*
Regulation of gene expression in yeast

Yuh-Hwa Wang, *Assistant Professor of Biochemistry, UMDNJ–RWJMS; Ph.D., North Carolina State*
Triplet repeat diseases, chromatin structure, fragile sites, DNA-protein interaction

William Welsh, *Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Pennsylvania*
Bioinformatics, cheminformatics, and computer-aided molecular design

Eileen P. White, *Howard Hughes Medical Institute Professor of Molecular Biology and Biochemistry, FAS–NB/CABM; Ph.D., SUNY (Stony Brook)*
Regulation of programmed cell death (apoptosis) by viral oncogenes and tumor suppressor genes

Nancy A. Woychik, *Associate Professor of Molecular Genetics and Microbiology, UMDNJ–RWJMS; Ph.D., Wisconsin (Madison)*
Regulation of mRNAtranscription; RNApolymerase II subunit function

Chung S. Yang, *Professor of Chemical Biology and Pharmacognosy, EMSP; Ph.D., Cornell*
Molecular mechanisms of esophageal carcinogenesis and its prevention, and other agents; genetic polymorphism and cancer risk

Lily Y.Young, *Professor of Environmental Sciences, CC; Ph.D., Harvard*
Anaerobic microbial metabolism of contaminant chemicals; microbial biodegrada - tion; bioremediation

Peter D. Yurchenco, *Professor of Pathology and Laboratory Medicine, UMDNJ–RWJMS; M.D., Ph.D., Albert Einstein College of Medicine*
Basement membrane; self-assembly; three-dimensional structure; cellular interactions

Barbara A. Zilinskas, *Professor of Plant Biochemistry, CC/BCAE; Ph.D., Illinois (Urbana-Champaign)*
Molecular biology of plant response to oxidative stress; photosynthesis

Gerben Zylstra, *Professor of Biochemistry and Microbiology, CC/BCAE; Ph.D., Michigan*
Microbial genomics, high-throughput screening; molecular analysis of biodegrada - tion pathways

Associate Members of the Graduate Faculty

Debra L. Laskin, *Professor of Pharmacology and Toxicology, EMSP; Ph.D., Medical College of Virginia*
Immunology; cytokines; nitric oxide; macrophages; inflammation

Jeffrey D. Laskin, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., SUNY (Buffalo)*
Effects of xenobiotics on growth and differentiation of epidermal cells; mechanisms of chemical carcinogenesis; biology of nitric oxide

Susan Rittling, *Research Assistant Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Vermont*
Role of osteopontin in tumorigenesis and bone metabolism

W. Steven Ward, *Associate Professor of Urology, UMDNJ–RWJMS; Ph.D., Vanderbilt*
Organization of DNAin the mammalian sperm nucleus

Adjunct Members of the Graduate Faculty

Marion Man-Ying Chan, *Assistant Research Professor of Biological Sciences, FAS–NB; Ph.D., Cornell Medical College*
Inflammation, immunity, and chemotherapy for intracellular parasite **Leishmania**

Roberto Rodriguez, *Amersham Pharmacia Biotech; Ph.D., Rutgers*
Geonomics and microassays

Programs

The graduate program in microbiology and molecular genetics offers advanced studies leading to the M.S. and Ph.D. degrees. Students get specialized training and have research opportunities in four areas: molecular genetics and microbial physiology; virology, immunology, and pathogenic microbiology; applied, environmental, and industrial microbiology; and computers in molecular biology. Admission to the Ph.D. program is offered through the consolidated graduate programs in molecular biosciences. For further information, refer to the molecular biosciences section. Students seeking admission to the program leading to a terminal M.S. degree should apply directly to the microbiology and molecular genetics program.

Students entering the program usually participate in a selection of core courses in the chosen area of interest. More information about the core courses in the program is available under the molecular biosciences heading in this chapter. Additional or alternate studies are designed to meet individual needs. Thus, graduate students have the opportunity to select additional study areas in their work.

Graduate study in microbiology and molecular genetics at Rutgers involves faculty members from several areas. The six major coordinating units are (1) the Division of Life Sciences of the Faculty of Arts and Sciences–New Brunswick, (2) the Waksman Institute of Microbiology, (3) the Department of Molecular Genetics and Microbiology of the University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School, (4) the Department of Biochemistry and Microbiology of Cook College, (5) the Center for Advanced Biotechnology and Medicine of the University of Medicine and Dentistry of New Jersey, and (6) the Biotechnology Center for Agriculture and the Environment.

The master of science degree requires the satisfactory completion of a minimum of 24 course credits, 6 research credits, and a research thesis. Candidates for the M.S. degree also are required to complete 2 credits from courses 16:681:681–686. (See further course requirements below.)

The doctor of philosophy degree requires 33 course credits and a minimum of two consecutive terms (summer included) in residence. Candidates must complete 5 credits from courses 16:681:681 through 16:681:686 (See further course requirements below). In addition, each student must pass a qualifying examination, complete a research project, submit a dissertation, and defend that dissertation in an oral examination. As part of their graduate training, doctoral students may be required to fulfill certain teaching duties under faculty supervision. There is no language requirement.

General Microbiology 16:681:501 and 16:681:502 Molecular Genetics or 16:681:580 Fundamentals of Molecular Genetics are required courses. Exemptions may be granted for students trans-ferring equivalent graduate credits.

The master of philosophy degree is available to doctoral candi-dates. All degrees in this program are conferred jointly between Rutgers University and the University of Medicine and Dentistry of New Jersey. For information about joint M.S. and Ph.D. degrees available in this program, see the beginning of this chapter. For detailed description of the program faculty, degree require-ments, and course offerings, refer to the *Student Bulletin* available from the program director.

Graduate Courses

The following courses have minimum prerequisites for undergradu-ate degrees in biochemistry, biology, chemistry, or microbiology with a concentration in genetics, organic chemistry, general biochemistry, or general microbiology.

16:681:501. (F) GENERAL MICROBIOLOGY (3)
Haggblom, Kerkhof
Molecular aspects of origin of life, microbial evolution, properties and synthesis of the major biological polymers, transport phenomena, metabolic pathways and regulation, cellular control mechanisms, virology, applied immunology, pathogenic microbiology, and food and industrial microbiology.

16:681:502. (S) Molecular Genetics (3)
Vershon. Prerequisites: 16:115:501,502.
Prokaryotic and eukaryotic molecular genetics. Bacteria, bacterio-phage, yeast, nematodes, *Drosophila,* plants, and mammals.

16:681:520. (F) Microbial Biochemistry and Molecular Biology (3)
Antoine. Prerequisites: 16:115:511,512, or equivalents; 16:681:521.
Survey of the biochemical activities unique to microorganisms emphasizing the similarities and differences between prokaryotic and eukaryotic organisms; consideration of the genetic regulation and practical importance of these biochemical capabilities. Topics include methanogenesis, toxins, biodegradation, microbial trans-formations, and secondary metabolites.

16:681:521. (S) Microbial Physiology and Metabolism (3)
Antoine. Prerequisites: 16:681:501, 16:115:511,512, or equivalents.
Microbial responses to environment with particular emphasis on nutrition and biochemistry. Enzymology and metabolic pathways of microorganisms. Metabolic diversity and regulation.

16:681:524. (S) Industrial Microbiology (3)
Eveleigh. Prerequisites: 16:681:501, one year of organic chemistry.
Industrial applications of microorganisms, including production of chemicals and antibiotics, transformations, product stability, protection from deterioration, impact on environment, continuous fermentations, and waste disposal.

16:681:530. (S) Introduction to Molecular Medicine (3)
Stollar
Application of molecular and cell biology to a wide variety of human diseases; recent advances in understanding basic mechanisms.

16:681:544. (S) Medical Microbiology and Immunology (4.5)
Bacteria and human cells in culture. Biochemical correlations. Comparative cytology, metabolism, genetics, regulation of protein synthesis and enzyme function, immunology, virology, and med-ical microbiology. Principles governing mechanisms of human disease emphasized.

16:681:545. (S) Medical Microbiology and Immunology Laboratory (2.5)
Corequisite: 16:681:544.
Experiments in the isolation, identification, and growth kinetics of bacteria; bioassay methods; organelle biogenesis; human kary-otyping; diagnostic bacteriology; immunological methods; animal cell culture and virology. Concepts and techniques relevant to medical problems emphasized.

16:681:548. Cell Surface Receptors (3)
Langer. Prerequisites: 16:115:501,502, or equivalent. Recommended: A course in cell biology.
Diverse prokaryotic and eukaryotic cell-surface receptors and their mechanisms of intracellular signaling examined to illustrate a range of experimental approaches, structural motifs, and bio-chemical mechanisms.

16:681:555. (F) Molecular Virology (3)
Stollar. Prerequisite: 16:681:501 or equivalent.
Detailed consideration of fundamental physical-chemical proper-ties, schemes of classification, genetics, and modes of replication of selected animal viruses.

16:681:572. (F) Microbial Ecology and Biodiversity (4)
Barkay. Lec. 3 hrs., lab. 3 hrs. Prerequisite: 16:681:501.
Qualitative and quantitative methods for the study of microbial communities. Ecological determinants. Characteristics of aquatic and terrestrial ecosystems. Biogeochemical cycles and energy flow. Microbial interactions and community structure.

16:681:580. (F) Fundamentals of Molecular Genetics (3)
Prerequisites: Genetics; 16:115:511,512.
Basic mechanisms of information storage in and retrieval from nucleic acids; organization of prokaryotic and eukaryotic genomes; mechanisms of DNA replication; transposable genetic elements; transcriptional and translational control of gene expression. Designed to provide necessary background for advanced molecular genetics courses.

16:681:585. (S) Cancer Molecular Biology (3)
Axelrod
Emphasis on the molecular, cellular, and genetic bases for cancer. Oncogenes and tumor suppressor genes. Signal transduction and cell cycle control in cancer cells. Metastasis. Diagnosis and therapy. Recent understanding of the molecular basis of selected human cancers. Lectures and critical discussion of the current literature.

16:681:601,602,603,604. Advanced Topics in Microbiology and Molecular Genetics (BA,BA,BA,BA)
Prerequisites: 16:681:501, 580. Recommended: 16:115:503,504.
Special topics of current interest.

16:681:607,608. Teaching Techniques in Microbiology and Molecular Genetics (2,2)
Prerequisite: Open only to matriculated students in the graduate program in microbiology and molecular genetics.
Guidance and practical experience in the teaching of microbiology and molecular genetics.

16:681:611,612,613,614. (F) Laboratory Rotation in Microbiology and Molecular Genetics (2,2,2,2)
Prerequisite: Written approval of program director. Open only to matriculated students in the graduate program.
Half-term research projects of interest to the student in faculty laboratories.

16:681:641,642,643,644,645,646. Independent Studies in Microbiology and Molecular Biology (BA,BA,BA,BA,BA,BA)
Prerequisites: Permission of faculty adviser and program director.
Library research project normally leading to a nonthesis essay for master's degree candidates.

16:681:681,682. Seminar in Molecular Genetics and Microbial Physiology (1,1)
Informal critical description and discussion of current literature and concepts.

16:681:683,684. Seminar in Virology, Immunology, and Pathogenic Microbiology (1,1)
Informal critical description and discussion of current literature and concepts.

16:681:685,686. Seminar in Applied, Environmental, and Industrial Microbiology (1,1)
Informal critical description and discussion of current literature and concepts.

16:681:687,688. Seminar in Computational Molecular Biology (1,1)
Recent advances in computational molecular biology selected from the following areas: genomics, bioinformatics, structural biology, image analysis, pattern formation, and molecular evolution.

16:681:701,702. Research in Microbiology and Molecular Genetics (BA,BA)

MOLECULAR AND CELL BIOLOGY 695

Program Offered: **Core Curriculum**
Director of Interdisciplinary Core Curriculum: **Professor Michael J.**
Leibowitz, Department of Microbiology, University of Medicine
and Dentistry of New Jersey–Robert Wood Johnson Medical
School, Piscataway, New Jersey 08854 (732/235-4795)

Core Curriculum Program

The Graduate School–New Brunswick and the University of
Medicine and Dentistry of New Jersey–Graduate School of
Biomedical Sciences offer a shared interdisciplinary core curricu-
lum in molecular and cell biology. The core curriculum provides
new course offerings and fellowship support to qualified students
who want to pursue Ph.D. degrees in the Consolidated Graduate
Programs in Molecular Biosciences.

Students enrolled in molecular and cell biology are expected
to follow the curriculum outlined below in their first year of study.
Subsequently, they are expected to proceed in one of the participat-
ing degree-granting programs. The core curriculum courses are to
be integrated into the requirements of the program in which
the student earns the degree. This curriculum is followed by all
students in the molecular biosciences programs.

Fall Term

16:115:501	Biochemistry (3)	
16:115:502	Biochemistry (Molecular Biology) (3)	
16:115:556	Ethical Scientific Conduct (1)	
16:695:611	Special Topics in Molecular and Cell Biology I (1)	
16:695:615	Laboratory Rotation in Molecular and Cell Biology I (4)	

Spring Term

16:681:502	Molecular Genetics (3)	
16:695:601	Advanced Cell Biology (3)	
16:695:612	Special Topics in Molecular and Cell Biology II (1)	
16:695:616	Laboratory Rotation in Molecular and Cell Biology II (2 or 4)	

Graduate Courses

16:695:601. ADVANCED CELL BIOLOGY (3)
Hitchcock-DeGregori, Pintar. Prerequisites: 16:115:501,502. Corequisites:
16:681:502, 16:695:612.
Molecular analysis of eukaryotic cells, including cell structure,
receptors, cell-cell interactions, cytoskeleton, growth, differentia-
tion, and transformation.

16:695:611,612. SPECIAL TOPICS IN MOLECULAR AND CELL
BIOLOGY I,II (1,1)
Leibowitz. Corequisites: 16:681:502; 16:695:601.
First term: student seminars and discussions based on assigned liter-
ature readings in biochemistry and molecular genetics, with empha-
sis on structure and function of macromolecules. *Second term:*
student seminars and discussions based on assigned literature read-
ings in molecular cell biology, with emphasis on molecular
approaches to cellular structures and activities in eukaryotic cells.

16:695:615,616. LABORATORY ROTATION IN MOLECULAR
AND CELL BIOLOGY I,II (4, 2 OR 4)
Leibowitz
Students participate in research projects in the laboratories
of selected faculty members.

MOLECULAR BIOPHYSICS 696

Program Offered: **Core Curriculum**
Director of Interdisciplinary Core Curriculum: **Professor Wilma K.**
Olson, Center for Molecular Biophysics and Biophysical
Chemistry, Wright-Rieman Laboratories, Busch Campus
(732/445-6376)

Participating Faculty

Members and associate members of the graduate faculty who par-
ticipate regularly in the molecular biophysics core curriculum are
identified below, along with the graduate programs in which
they participate.

Stephen Anderson, *Biochemistry*
Edward Arnold, *Chemistry and Chemical Biology*
Jean S. Baum, *Chemistry and Chemical Biology*
Helen M. Berman, *Chemistry and Chemical Biology, BioMaPS*
Kenneth J. Breslauer, *Chemistry and Chemical Biology*
Barbara M. Brodsky, *Biochemistry*
Edward W. Castner, Jr., *Chemistry and Chemical Biology*
Bernard D. Coleman, *Mechanics*
Richard H. Ebright, *Chemistry and Chemical Biology, BioMaPS*
Martin Farach-Colton, *Computer Science*
Marc R. Gartenberg, *Pharmacology*
Masayori Inouye, *Biochemistry*
Stephan S. Isied, *Chemistry and Chemical Biology*
Roger A. Jones, *Chemistry and Chemical Biology*
Karsten Krogh-Jespersen, *Chemistry and Chemical Biology*
Casimir Kulikowski, *Computer Science*
Jeehiun K. Lee, *Chemistry and Chemical Biology*
John Lenard, *Physiology and Integrative Biology*
Ronald M. Levy, *Chemistry and Chemical Biology, BioMaPS*
Richard D. Ludescher, *Food Science*
Gerald S. Manning, *Chemistry and Chemical Biology*
Gaetano T. Montelione, *Biochemistry*
Wilma K. Olson, *Chemistry and Chemical Biology, BioMaPS*
Daniel S. Pilch, *Pharmacology*
Andrei Ruckenstein, *Physics and Astronomy*
Anirvan M. Sengupta, *Physics and Astronomy*
Boris I. Shraiman, *Physics and Astronomy*
Ann M. Stock, *Biochemistry*
David S. Talaga, *Chemistry and Chemical Biology*
John W. Taylor, *Chemistry and Chemical Biology*
T.J. Thomas, *Biochemistry*
Thresia Thomas, *Microbiology and Molecular Genetics*

Core Curriculum Program

The aim of the molecular biophysics core curriculum is to select and
educate researchers who are capable of applying the tools and con-
cepts of the physical sciences to the solution of significant biological
problems. Many important contributions in molecular biophysics
are a synthesis of biology, chemistry, mathematics, and physics not
found in a single traditional discipline. The molecular biophysics
core curriculum therefore goes beyond the curricula of individual
academic disciplines and sets its own guidelines for courses and
the character of dissertation research. The requirements are, never-
theless, consistent with those of existing graduate programs at
Rutgers so that the students can earn a Ph.D. in one of the major
academic disciplines with a concentration in molecular biophysics.

Supplemental work for molecular biophysics is designed to
enable the students to do the following: (1) receive broad exposure
to the principles and methods of molecular biophysics along with
rigorous training in the relevant physical science, (2) combine
course requirements with those in existing predoctoral programs,
(3) choose from a wide range of courses in molecular biophysics
not specifically included in the requirements, and (4) master a
curriculum that meets his or her individual needs.

Because students in the program come from a variety of back-
grounds and have different interests, the course structure is flexible.
Formal course requirements are limited to a core program in bio-
physical chemistry and a choice of two advanced courses.

All students are expected to complete a sequence of laboratory
rotations and to register ever term for the core curriculum seminar.
The laboratory rotation is intended to provide students with broad
exposure to the methods of molecular biophysics and to assist them
in choosing dissertation advisers. The aim of the seminar course is to
provide in-depth exposure to new developments in the field as well
as to unify the molecular biophysics students and faculty. Students
also work in depth with a faculty mentor on a dissertation problem.
The emphasis of the research training is on the structures, interac-
tions, and physicochemical properties of biological macromolecules.

The program additionally offers wide latitude in the choice of advanced electives, allowing students and faculty to design curricula to match individual needs. Students in the program are expected to have a common minimal background in the physical and biological sciences. Courses are taken to fill gaps in background as well as to provide intensive training in the particular area in which the student plans to carry out research. The departmental courses offered at Rutgers provide a rich resource for this purpose. Most students are expected to take four to five years to complete degree requirements.

Graduate Courses

Biophysical Chemistry I,II, 16:160:537,538, and 16:115:556 Ethical Scientific Conduct are required courses. Exemptions may be granted for students transferring equivalent graduate credits. Students can select advanced electives in molecular biophysics from a long list of existing courses in several graduate programs.

16:696:601,602. SEMINAR IN MOLECULAR BIOPHYSICS (1,1)
Oral presentations and discussions of the current literature in molecular biophysics.

16:696:611,612. LABORATORY ROTATION IN MOLECULAR BIOPHYSICS (BA,BA)
Introduction to the techniques and research areas of molecular biophysics. Participation in the research projects of two to three faculty members. Students are encouraged to take rotations in different areas. At least one of the rotations should be involved with the structural investigation (either by experimental or theoretical means) of a biopolymer.

MOLECULAR BIOSCIENCES

The Consolidated Graduate Programs in Molecular Biosciences coordinates recruitment and admission of applicants to the doctoral programs in biochemistry, cell and developmental biology, microbiology and molecular genetics, physiology and integrative biology, and cellular and molecular pharmacology. As part of this task, it has established a common first-year doctoral core curriculum for those disciplines. The consolidated programs are conducted jointly by the Graduate School–New Brunswick of Rutgers University and the Graduate School of Biomedical Sciences of the University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School.

Students may study with more than 200 participating faculty members affiliated with these programs. They have opportunities for study in such fields as biochemistry, biotechnology, cell biology, computational molecular biology, developmental biology, macromolecular structure, microbiology, molecular biology, molecular biophysics, molecular genetics, molecular virology, and protein engineering.

Admission Requirements

The best preparation for the molecular biosciences consists of an undergraduate degree in biology (cellular, developmental, molecular, or microbiology), in biochemistry, or in chemistry (analytical, organic, or physical). Applicants must have adequate backgrounds in calculus and physics, and all applicants are required to have earned an undergraduate cumulative grade-point average of 3.0 or better.

Faculty Affiliations

Rutgers, The State University of New Jersey

Faculty of Arts and Sciences–New Brunswick/Division of Life Sciences

Department of Cell Biology and Neuroscience
Department of Chemistry
Department of Genetics
Department of Molecular Biology and Biochemistry
Department of Psychology

Ernest Mario School of Pharmacy

Department of Chemical Biology and Pharmacognosy

Cook College

Department of Animal Sciences
Department of Biochemistry and Microbiology
Department of Food Science

University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School

Department of Biochemistry
Department of Cell and Molecular Pharmacology
Department of Medicine (and other clinical departments)
Department of Molecular Genetics and Microbiology
Department of Neurosciences and Cell Biology
Department of Pathology
Department of Physiology and Biophysics

Academic Research Centers and Institutes

Biotechnology Center for Agriculture and the Environment (BCAE)
Cancer Institute of New Jersey (CINJ)
Center for Advanced Biotechnology and Medicine (CABM)
Center for Advanced Food Technology (CAFT)
Center of Alcohol Studies (CAS)
Center for Computer Aids for Industrial Productivity (CAIP)
Center for Molecular Biophysics and Biophysical Chemistry (CMB)
Center for Theoretical and Applied Genetics (CTAG)
Environmental and Occupational Health Sciences Institute (EOHSI)
Waksman Institute of Microbiology (WIM)

First-Year Core Curriculum

Fall Term

16:115:501	Biochemistry (3)	
16:115:502	Biochemistry (Molecular Biology) (3)	
16:115:556	Ethical Scientific Conduct (1)	
16:695:611	Special Topics in Molecular and Cell Biology I (1)	
16:695:615	Laboratory Rotation in Molecular and Cell Biology I (4)	

Spring Term

16:681:502	Molecular Genetics (3)	
16:695:601	Advanced Cell Biology (3)	
16:695:612	Special Topics in Molecular and Cell Biology II (1)	
16:695:616	Laboratory Rotation in Molecular and Cell Biology II (2 or 4)	
	one elective course (3)	

For information regarding specific areas of study as well as course listings, see the program descriptions for biochemistry, cell and developmental biology, cellular and molecular pharmacology, and microbiology and molecular genetics within this chapter of the catalog and in related materials from UMDNJ–RWJMS.

MUSIC 700

Degree Programs Offered: **Master of Arts, Doctor of Philosophy**
Director of Graduate Program: **Professor Richard Chrisman, 114 Marryott Music Building, Douglass Campus (732/932-9272)**

Members of the Graduate Faculty

William Berz, *Professor of Music, MGSA; Ph.D., Michigan State*
Music education; instructional technology
Antonius Bittmann, *Assistant Professor of Music, MGSA; Ph.D., Eastman School of Music (Rochester)*
Performance practice, organ
Gerald C. Chenoweth, *Professor of Music, MGSA; Ph.D., Iowa*
Music composition; theory and analysis
Richard Chrisman, *Associate Professor of Music, MGSA; Ph.D., Yale*
Contemporary music theory

Nanette de Jong, *Assistant Professor of Music, MGSA; Ph.D., Michigan*
Ethnomusicology; flute
Floyd Grave, *Associate Professor of Music, MGSA; Ph.D., New York*
Eighteenth-century music; history of music theory
Rufus E. Hallmark, Jr., *Chair and Professor of Music, MGSA; Ph.D., Princeton*
Nineteenth-century music; German lied
Douglas Johnson, *Professor of Music, MGSA; Ph.D., California (Berkeley)*
Eighteenth- and 19th-century music; Beethoven
Andrew Kirkman, *Associate Professor of Music, MGSA; Ph.D.,*
Kings College (London)
Renaissance music; early vocal music performance
Nancy Rao, *Assistant Professor of Music, MGSA; Ph.D., Michigan*
Music theory and analysis
George Stauffer, *Dean of MGSA and Professor of Music; Ph.D., Columbia*
Baroque music; J.S. Bach
Charles Wuorinen, *Professor of Music, MGSA; M.A., Columbia*
Music composition; electronic sound synthesis; theory and analysis

Programs

Graduate music programs at Rutgers prepare students for music scholarship, on the one hand, or composition, on the other. Both areas include extensive study of music theory.

The M.A. degree requires a minimum of 30 credits. For students specializing in composition, the following courses are required: 16:700:501, 525, 526, 531, 532, 601, and 602. Those concentrating in musicology must take 16:700:501, 502, 519, 520, 525, and one other theory class, 552, and 602. The music history faculty recommends that musicology students take one course outside the department. Before the end of their second term of full-time study, all candidates must take an examination that will determine their eligibility to remain in the program. This examination will require students to identify important composers and compositions. Before the end of the third term, students seeking an M.A. degree must demonstrate a reading knowledge of one foreign language (German, French, Italian, or Latin). Those M.A. candidates who plan to continue for a Ph.D. must demonstrate a reading knowledge of two foreign languages before they complete their work in the M.A. program. One of the two languages should be German, as this language is required for the Ph.D. All candidates must pass a written comprehensive examination. Candidates in musicology submit a master's essay. Those in composition submit a work for chamber ensemble.

For admission to the Ph.D. program, applicants must have met requirements for the M.A. degree or their equivalents. Applicants in musicology should submit an essay giving evidence of their ability to engage in scholarly research. Applicants in composition should submit a work based on a traditional procedural model, such as a motet, chorale prelude, invention, or fugue. They also must provide a portfolio of their recent, representative compositions. Ph.D. candidates in composition must take 16:700:631, 632, 651, and 9 elective credits. Ph.D. candidates in musicology must take 16:700:619, 620, 651, and 9 elective credits. In addition, a minimum of 24 credits in individual research is required. Students should have met all language requirements by the end of the third year of graduate study. Students in musicology must show in a written examination that they have a reading knowledge of French, German, and a third language that is chosen with approval of the graduate director. Students in composition must demonstrate by the end of their third year a working knowledge of German and of one Romance language, which is chosen with approval of the graduate director. As part of their graduate training, doctoral students also are required to fulfill certain teaching duties under faculty supervision. Before admission to candidacy for the Ph.D. degree, all students must pass a written and oral comprehensive examination. For students in musicology, a dissertation is required. Candidates in composition must submit an original work of substantial proportions, along with an appropriate critical or theoretical essay.

The master of philosophy degree is available to doctoral candidates. The faculty cooperates with the M.A. program in theology, with a major in music, offered by the New Brunswick Theological Seminary.

All students of composition (both M.A. and Ph.D. candidates) are expected to participate in the Composer Forum, a periodic meeting of students and faculty that provides a setting for the performance and discussion of students' music.

In addition to courses listed below, a student may, with approval of the graduate director, receive credit for certain upper-level, relevant undergraduate or graduate classes offered by other departments. One example would be 01:730:365 Philosophy of Music, which is offered by the philosophy department.

Graduate Courses

16:700:501. (F) INTRODUCTION TO MUSIC RESEARCH (3)
Survey of bibliographic materials for research in music.

16:700:502. CURRENT ISSUES IN MUSICOLOGY (3)
Discussion of musicological issues from across the historical and methodological spectra.

16:700:511,512. MUSIC THEORY—INTENSIVE REVIEW (3,3)
Review of counterpoint (two- and three-part species counterpoint, including imitation); harmony (part-writing and progressions); sight-reading and analysis.

16:700:515,516. SOUND SYNTHESIS AND COMPUTER-ASSISTED COMPOSITION (3,3)
Prerequisite: Permission of instructor.
Analysis of sound and timbre. Use of the computer for musical composition.

16:700:517. THE HISTORY OF MUSICAL STYLE (3)
Prerequisite: Permission of instructor.
Aspects of convention and innovation in composers' approach to sonority, harmony, melody, rhythm, and form in representative vocal and instrumental compositions from different historical periods, ca. 1600–1950.

16:700:519,520. PROSEMINAR IN MUSICOLOGY (3,3)
Prerequisites: 16:700:501, 502.
Intensive study of selected areas in the history of music, with guided research leading to oral and written reports.

16:700:522. CANON AND FUGUE (3)
Exercises in polyphonic technique based on practices from the Renaissance to the tonal period.

16:700:525,526. STUDIES IN MUSIC ANALYSIS (3,3)
Study of styles and structures in compositions from the Middle Ages to the present and their relationship to ideas on composition held by composers and theorists.

16:700:527. STUDIES IN OPERA (3)
Prerequisite: Permission of instructor. Offered in alternate years.
Study of selected operas. Historical background, sources, editions, textual criticism, analysis, performance practice.

16:700:528. STUDIES IN CHORAL LITERATURE (3)
Prerequisite: Permission of instructor. Offered in alternate years.
Study of selected works for chorus and vocal ensemble from the 16th century to the present. Historical background, sources, editions, textual criticism, analysis, performance practice.

16:700:529. STUDIES IN INSTRUMENTAL ENSEMBLE LITERATURE (3)
Prerequisite: Permission of instructor. Offered in alternate years.
Study of selected chamber and orchestral works from the 17th century to the present. Historical background, sources, editions, textual criticism, analysis, performance practice.

16:700:530. STUDIES IN KEYBOARD LITERATURE (3)
Prerequisite: Permission of instructor. Offered in alternate years.
Study of selected works for keyboard instruments. Historical background, sources, editions, textual criticism, analysis, performance practice.

16:700:531,532. PROSEMINAR IN COMPOSITION (3,3)
Prerequisite: Permission of instructor.
Practice in the techniques of creative composition. Includes participation in the Composer Forum.

16:700:541,542. SPECIAL TOPICS IN MUSIC THEORY AND ANALYSIS (3,3)
Prerequisite: Permission of instructor.
Study of selected musical repertories and styles from a variety of theoretical perspectives.

16:700:551. JAZZ RESEARCH AND ANALYSIS (3)
Prerequisite: 16:700:501. Recommended: 16:700:525 (as pre- or corequisite).
Introduction to scholarly research in jazz. Covers research methods, transcription, and analysis of recorded jazz performances, pertinent African-American cultural issues, and questions of performance practice.

16:700:552. INTRODUCTION TO ETHNOMUSICOLOGY (3)
Prerequisite: Permission of instructor.
Introduction to the theory and methodology of ethnomusicology; current issues and intellectual history.

16:700:567,568. PROSEMINAR IN PERFORMANCE PRACTICE (3,3)
Prerequisite: Permission of instructor.
Problems of performance technique and interpretation from the Renaissance to the present.

16:700:571,572. SCHENKERIAN ANALYSIS (3,3)
Prerequisite: Permission of instructor. Offered in alternate years.
Premises, terminology, and analytical procedures derived from Heinrich Schenker's theory of linear structure, with emphasis on verification of analysis through critical listening.

16:700:573,574. TWENTIETH-CENTURY THEORY (3,3)
Prerequisite: Permission of instructor. Offered in alternate years.
Analysis of selected compositions from ca. 1910 to the present. Theoretical strategies and perspectives.

16:700:601. INDEPENDENT STUDY (BA)
For those specializing in musicology: individual research leading to an essay demonstrating command of the techniques of historical or analytical research. For those specializing in music composition: individual research leading to a composition of substantial size demonstrating command of the techniques of composition.

16:700:602. MASTER'S PROJECT (BA)
Prerequisite: 16:700:601.
Completion of the essay or composition required for the M.A. degree.

16:700:619,620. SEMINAR IN MUSICOLOGY (3,3)
For students pursuing the doctoral program.
Individual research in selected areas of music history and musicology.

16:700:631,632. SEMINAR IN COMPOSITION (3,3)
For students pursuing the doctoral program.
Advanced study in the techniques of creative composition. Includes participation in the Composer Forum.

16:700:651. HISTORY OF MUSIC NOTATION (3)
Prerequisite: Permission of instructor. Offered in alternate years.
Intensive study of medieval and Renaissance notational systems, with exercises in transcription from selected representative sources.

16:700:652. TOPICS IN THE HISTORY OF MUSIC THEORY (3)
Prerequisite: Permission of instructor.
Close examination of selected theoretical writings from antiquity to the 20th century, with emphasis on the study of tuning systems, modes, tonality, and acoustics.

16:700:701,702. RESEARCH IN MUSIC (BA,BA)
Individual research leading either to a musical composition, to an extended essay in an area of music history or theory, or toward completion of the Ph.D. degree.

MUSIC
(See the catalog of the Mason Gross School of the Arts for information about programs that lead to the M.M., A.Dpl., and D.M.A. in music.)

NEUROSCIENCE 710

Degree Program Offered: **Doctor of Philosophy**
Director of Graduate Program: **Professor Ira B. Black, Room 342, CABM, Busch Campus (732/235-5388)**

Members of the Graduate Faculty

Cory Abate-Shen, *Associate Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS/CABM; Ph.D., Cornell Medical College*
Molecular processes that control gene expression during mammalian neuronal development

Kurt F. Amsler, *Assistant Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., Tennessee*
Signal transduction and control of epithelial growth and differentiation

Sidney B. Auerbach, *Associate Professor of Biological Sciences, FAS–NB; Ph.D., Wisconsin (Madison)*
Control of neurotransmitters in the brain

Ira B. Black, *Chairperson and Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS/CABM; M.D., Harvard*
Environmental regulation of brain gene expression; role of growth and trophic factors; synaptic plasticity

Patrizia Casaccia-Bonnefil, *Assistant Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS; M.D., Ph.D., SUNY (Health Science Center at Brooklyn)*
Cell cycle regulation and apoptosis signaling in progenitor cells in CNS

Timothy M. Casey, *Professor of Entomology, CC; Ph.D., California (Los Angeles)*
Respiration; bioenergetics; thermoregulation

Kuang-Yu Chen, *Professor of Chemistry, FAS–NB; Ph.D., Yale*
Protein kinase pathway in neuronal development; neuroblastoma differentiation

Daniel S. Cowen, *Assistant Professor of Psychiatry, UMDNJ–RWJMS; M.D., Ph.D., Case Western Reserve*
Coupling of 5-HT receptors to cellular signals for protein synthesis

Robin L. Davis, *Associate Professor of Biological Sciences, FAS–NB; Ph.D., Stanford*
Regeneration and electrophysiology of peripheral auditory neurons

Emanuel M. DiCicco-Bloom, *Associate Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS/CABM; M.D., Cornell Medical College*
Cellular and molecular regulation of neurogenesis in vivo and in vitro

Cheryl F. Dreyfus, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS/CABM; Ph.D., Cornell*
Role of environmental factors on brain neuron ontogeny

Monica Driscoll, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB/CABM; Ph.D., Harvard*
Molecular genetics of neurodegeneration; mechanotransduction

Isaac Edery, *Assistant Professor of Molecular Biology and Biochemistry, FAS–NB/CABM; Ph.D., McGill*
Molecular mechanism underlying biological clocks

M. David Egger, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS; Ph.D., Yale*
Neurophysiology; neuroanatomy; neurogenetics

Julie M. Fagan, *Associate Professor of Animal Sciences, CC; Ph.D., Arizona*
Muscle growth; mechanisms of protein breakdown in mammalian cells in health and in disease

Allahverdi Farmanfarmaian, *Professor of Biological Sciences, FAS–NB; Ph.D., Stanford*
Membrane transport; comparative physiology

Bonnie Firestein, *Assistant Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., California (San Diego)*
Targeting of neuronal proteins

Bijan K. Ghosh, *Professor of Physiology and Biophysics, UMDNJ–RWJMS; D.Sc., Calcutta*
Protein transport; membrane differentiation

Martin Grumet, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Johns Hopkins*
Molecular mechanisms of cell adhesion in the nervous system

Ronald Hart, *Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., Michigan*
Neuroimmunology of central nervous system injuries

Shu-Chan Hsu, *Assistant Professor of Cell Biology and Neuroscience, FAS–NB; Ph.D., British Columbia*
Molecular mechanisms of synoptic development and function

Arnold G. Hyndman, *Professor of Biological Sciences, FAS–NB; Ph.D., California (Los Angeles)*
Development of CNS neurons

William G. Johnson, *Professor of Neurology, UMDNJ–RWJMS; M.D., Columbia*
Locating and cloning genes for human nervous system traits and disorders

Bela Julesz, *Professor of Psychology, FAS–NB; Ph.D., Hungarian Academy of Sciences*
Visual perception

Joseph Kedem, *Associate Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., Hebrew (Jerusalem)*
Quantitative relation between cardiac function and metabolism

Alexander Kusnecov, *Assistant Professor of Psychology, FAS–NB; Ph.D., Newcastle*
Neurobiological and behavioral effects of cytokines from the brain and immune system

John Lenard, *Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., Cornell*
Insulin actions in fungi; virus membrane assembly and disassembly

John K-J. Li, *Professor of Biomedical Engineering, SE; Ph.D., Pennsylvania*
Cardiovascular dynamics and hypertension; instrumentation

Michael Matise, *Assistant Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS; Ph.D., Pittsburgh*
Molecular mechanisms of vertebrate nervous system development

Randall D. McKinnon, *Associate Professor of Surgery, UMDNJ–RWJMS; Ph.D., McMaster*
Growth factors and glia

Gary F. Merrill, *Professor of Biological Sciences, FAS–NB; Ph.D., Michigan State*
Regulation of coronary blood flow

James Millonig, *Assistant Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS; Ph.D., Princeton*
Vertebrate CNS development

Judith A. Neubauer, *Associate Professor of Medicine, UMDNJ–RWJMS; Ph.D., Rutgers*
Neurobiology of respiratory control: neuronal responses to hypoxia and CO_2

Richard S. Nowakowski, *Associate Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS; Ph.D., Harvard*
Development of central nervous system

Timothy Otto, *Associate Professor of Psychology, FAS–NB; Ph.D., New Hampshire*
Neurobiology of memory; synaptic plasticity; rodent olfactory learning

Richard Padgett, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., North Carolina*
*TGFP signaling in **Drosophila** and **C. elegans;** developmental biology*

Charles H. Page, *Professor of Biological Sciences, FAS–NB; Ph.D., Illinois*
Cellular neurophysiology and motor control

Thomas V. Papathomas, *Associate Professor of Biomedical Engineering, FAS–NB; Ph.D., Columbia*
Mechanisms and models for stereo, motion, and texture perception

Nicola Partridge, *Professor and Chairperson of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., Western Australia*
Signal transduction mediating hormone action; matrix metalloproteinases

John E. Pintar, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS/CABM; Ph.D., Oregon*
Role of insulin growth factor family during embryogenesis; development biology of the pituitary gland

Mark R. Plummer, *Associate Professor of Biological Sciences, FAS–NB; Ph.D., Stanford*
Modulation and regulation of calcium channels in mammalian CNS neurons

Jamshid Rabii, *Associate Professor of Biological Sciences, FAS–NB; Ph.D., California (San Francisco)*
Neuroendocrine regulation of prolactin, LH, and other pituitary hormones

David J. Riley, *Professor of Medicine, Adjunct Professor of Physiology and Biophysics, UMDNJ–RWJMS; M.D., Maryland*
Respiratory physiology

Christopher Rongo, *Assistant Professor of Genetics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Formation and plasticity of synapses in the central nervous system

Dipak Sarkar, *Professor and Chairperson of Animal Sciences, CC; Ph.D., Oxford*
Molecular mechanisms of neuroendocrine cell growth and differentiation

Michael M. Shen, *Assistant Professor of Pediatrics, UMDNJ–RWJMS/CABM/CINJ; Ph.D., Cambridge*
Analyses of growth factor signaling in vertebrate neural development

Tetsuo Shimamura, *Professor of Pathology, UMDNJ–RWJMS; M.D., Ph.D., Yokohama*
Renal structure and function

Arabinda K. Sinha, *Associate Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., California (San Francisco)*
Metabolic alterations between sleep and wakefulness

Patricia Sonsalla, *Associate Professor of Neurology, UMDNJ–RWJMS/EOHSI; Ph.D., Utah*
Neurodegeneration, Parkinson's disease, neuropharmacology of dopamine neurons

Judith M. Stern, *Professor of Psychology, FAS–NB; Ph.D., Rutgers*
Sexual and maternal behaviors in animals and women

Nancy R. Stevenson, *Associate Professor of Physiology, UMDNJ–RWJMS; Ph.D., Rutgers*
Digestive absorptive functions; gastrointestinal function

Mark Takahashi, *Associate Professor of Physiology, UMDNJ–RWJMS; Ph.D., Wisconsin*
Enzymology; signal transduction mechanisms in cytokine-induced differentiation

William G. Wadsworth, *Assistant Professor of Pathology, UMDNJ–RWJMS; Ph.D., Missouri*
*Extracellular matrix and axonal guidance in **C. elegans***

George Wagner, *Professor of Psychology, FAS–NB; Ph.D., Chicago*
Neurochemical mechanisms underlying behavior

Harvey R. Weiss, *Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., Duke*
Circulatory and cardiac physiology

Mark O. West, *Professor of Psychology, FAS–NB; Ph.D., Bowman Gray*
Analysis of basal ganglia and limbic circuits in the rat during behavior and in electrophysiological response to drugs

Kuo Wu, *Associate Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS/CABM; Ph.D., SUNY (Brooklyn)*
Elucidation of molecular mechanisms that regulate synaptic structure

Wise Young, *Professor of Cell Biology, Developmental Biology, and Neurobiology, FAS–NB; Ph.D., Iowa; M.D., Stanford*
Spinal cord nerve regeneration

Edward J. Zambraski, *Professor of Biological Sciences, FAS–NB; Ph.D., Iowa*
Renal and exercise physiology

Gail Zeevalk, *Associate Professor of Neurology, UMDNJ–RWJMS; Ph.D., CUNY*
Mechanisms of neuronal damage in models of neurodegenerative disease

James Q. Zheng, *Assistant Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS; Ph.D., Tsinghua*
Molecular/cellular mechanisms underlying the formation of neuronal circuitry

Renping Zhou, *Associate Professor of Chemical Biology, EMSP; Ph.D., California (Berkeley)*
Development of the brain: function of growth factors and their receptors

Associate Members of the Graduate Faculty

Juan P. Advis, *Associate Professor of Animal Sciences, CC; Ph.D., Texas D.V.M., Austral (Chile)*
Neuroendocrinology of reproduction

David Crockett, *Associate Professor of Neuroscience and Cell Biology; UMDNJ–RWJMS; Ph.D., CUNY*
Somatosensory systems development, spinal cord injury, neurotrophins

Alan Gelperin, *Monell Chemicals; Ph.D., Pennsylvania*
*Olfactory information processing and learning in **Limax maximus***

Joseph V. Martin, *Associate Professor of Zoology; FAS–C; Ph.D., Southern California*
Mechanisms of action of hypnotic drugs

William M. Saidel, *Associate Professor of Zoology; FAS–C; Ph.D., Massachusetts Institute of Technology*
Vision in fishes and the evolution of vision

Michael V.K. Sukhdeo, *Associate Professor of Animal Sciences, CC; Ph.D., McGill*
Behavioral ecology of parasitic helminths in the host environment

Program

This graduate program is administered in a cooperative, integrated fashion by faculties in animal sciences, biological sciences, neuroscience and cell biology, pharmacology, and psychology. Areas of specialization include gene action in the brain; biophysics; mechanisms and regulatory controls of learning and memory; and developmental neurobiology.

The program selects students on the basis of their academic records, Graduate Record Examination scores, and references. A student must have an undergraduate cumulative grade-point average of at least *B* to be considered for admission. Prerequisite courses include biology, general and organic chemistry, calculus, and physics. Applications are accepted throughout the year, but normally are completed by March 1 for admission to study for the fall term. Financial aid is provided to highly qualified students. Financial aid typically includes a stipend to cover living expenses and remission of tuition fees. Three classes of direct support are available: (1) fellowships, (2) graduate assistantships provided through research grants held by individual professors, and (3) teaching assistantships associated with individual teaching units of the program.

While doctoral requirements vary with the area of specialization, at least 28 course credits are required, of which 24 must be at the 500 level or above. Because students must pass a qualifying examination in neurobiology for acceptance into the doctoral program, they should be knowledgeable in neural anatomy, neurophysiology, neural chemistry, neuropharmacology, neuroendocrinology, neural develop-

ment, and the neural bases of behavior. The program has no foreign language requirement. To meet the residence requirements in the program, a student must be registered for 24 credits of course work or research or some combination of both within one period of 12 consecutive months during his or her doctoral training.

For more information about joint Ph.D. degrees available in this program, see the beginning of this chapter.

Graduate Courses

16:710:511. (S) HISTORY OF NEUROSCIENCE (2)
Prerequisite: Interest in neuroscience.
The origins of neuroscience from antiquity to the current era. Changing concepts of brain function, the development of the neuron theory, localization of function, and the role of instrumentation in the development of neuroscience.

16:710:517. (S) MOLECULAR NEUROTRANSMISSION (2)
Wu. 2 hrs., 15 weeks. Prerequisite: 16:710:557.
Emphasis on current topics on molecular mechanisms that govern neuron-to-neuron communication through chemical pathways in the mammalian brain; pharmacological and pathological conditions.

16:710:540. (S) TROPHIC MECHANISMS IN THE NERVOUS SYSTEM (2)
Dreyfus. 1.5 hrs., 14 weeks. Prerequisites: Cell biology, neurobiology, and biochemistry. Offered in even-numbered years.
Introduction to neurotropic factor field. In particular, the critical nature of trophic agents in the establishment and maintenance of a functioning nervous system.

16:710:544. (F) MOLECULAR REGULATION OF NEUROGENESIS (2)
DiCicco-Bloom. Prerequisites: Neurobiology, molecular biology of cells. Offered in even-numbered years.
Discussion of current literature, explores concepts and mechanisms regulating neuronal generation, and specification from undifferentiated precursors in invertebrates and vertebrates examined, including cell lineage, homeotic genes, neurotransmitters, and growth, trophic, and transcription factors.

16:710:545. (F) REPRODUCTION (3)
Sukhdeo

16:710:546. (S) NEUROENDOCRINOLOGY (3)
Rabii. Prerequisites: Mammalian physiology and permission of instructor. Recommended: General endocrinology.
Principles of neurosecretion and neuroendocrine regulation. The CNS control of hormone secretion and function.

16:710:554. (F) GENE REGULATION IN NEURAL DEVELOPMENT (2)
Abate-Shen. Offered in odd-numbered years. See also 16:115:554.
Survey of recent literature regarding the regulation of gene expression in the nervous system. Emphasis on the molecular mechanisms involved in gene regulation during neuronal development.

16:710:555. (F) NEUROBIOLOGY (4)
Plummer. Recommended: Biochemistry, physiology, or animal behavior.
Introductory survey emphasizing experimental approaches to the study of invertebrate and vertebrate nervous systems. Molecular, biophysical, and biochemical bases of nerve cell function. Higher-level functions shown as emerging from nerve cell properties, anatomical development, and mature connections. See also 16:830:555.

16:710:557. (S) NEUROSCIENCE (4)
Nowakowski. Lec. 3 hrs., lab. and demonstration 3 hrs.
Study of the human central nervous system involving gross and microscopic examination and physiological study of the brain, spinal cord, receptors, and effectors with correlated clinical demonstration of neurological disorders.

16:710:558,559. SPECIAL TOPICS IN NEUROBIOLOGY (2,2)
Prerequisite: Permission of instructor.
Analysis and discussion of contemporary research in cellular and molecular aspects of neuronal functioning, or of selected topics of current research in developmental neurobiology examined by historical review, presentation of current research papers, and analysis of new approaches and unifying theories, in alternating terms.

16:710:605,606. ADVANCED STUDIES IN PHYSIOLOGY AND NEUROBIOLOGY (BA,BA)
Research literature review or independent reading.

16:710:701,702. RESEARCH IN PHYSIOLOGY AND NEUROBIOLOGY (BA,BA)
Prerequisite: Permission of instructor.

NUTRITIONAL SCIENCES 709

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Malcolm Watford, 132 Thompson Hall, Cook Campus (732/932-9039)**

Members of the Graduate Faculty

John D. Bogden, *Professor of Preventive Medicine and Community Health, UMDNJ–RWJMS; Ph.D., Seton Hall*
Trace element nutrition and toxicology

Dawn L. Brasaemle, *Assistant Professor of Nutritional Sciences, CC; Ph.D., Wisconsin (Madison)*
Biology of neutral lipid storage and release

Robert E. Brolin, *Professor of Surgery, St. Peter's University Hospital; M.D., Michigan*
Treatment of medically severe obesity; intestinal ischemic disease

Wendie S. Cohick, *Assistant Professor of Animal Sciences, CC; Ph.D., Cornell*
Hormonal regulation of mammary gland biology and lactational physiology

Julie M. Fagan, *Associate Professor of Animal Sciences, CC; Ph.D., Arizona*
Oxidative damage; antioxidant defense on aging and disease processes

Ronaldo P. Ferraris, *Associate Professor of Physiology, UMDNJ–NJMS; Ph.D., Hawaii (Manoa)*
Gastrointestinal physiology; membrane transport of nutrients; intestinal function/dysfunction in aging

Hans Fisher, *Professor of Nutritional Sciences, CC; Ph.D., Illinois*
Tryptophan and serotonin metabolism in the brain, with special reference to alcoholism and behavior

Peter J. Guarnaccia, *Associate Professor of Human Ecology, CC; Ph.D., Connecticut*
Anthropology of foods and health

Daniel Hoffman, *Assistant Professor of Nutritional Sciences, CC; Ph.D., Tufts*
Early nutrition, obesity, diabetes, undernutrition in utero and during early childhood

Barry W. Jesse, *Associate Professor of Animal Sciences, CC; Ph.D., Michigan State*
Nutritional biochemistry of ruminant livestock

Debra P. Keenan, *Assistant Professor of Nutritional Sciences, CC; Ph.D., Pennsylvania State*
Nutrition education

Paul A. Lachance, *Professor of Food Science, CC; Ph.D., Ottawa*
Applied human nutrition; nutrition and food processing; nutraceuticals

Debra L. Laskin, *Associate Professor of Pharmacology and Toxicology, EMSP; Ph.D., Medical College of Virginia*
Mechanisms of immune cell activation; role of inflammatory cells in the pathogenesis of tissue injury

Soo-Kyung Lee, *Assistant Professor of Nutritional Sciences, CC; Ph.D., Cornell*
Diet, obesity, health and acculturation among minority populations

Peter Lobel, *Associate Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Columbia*
Protein targeting, mannose 6-phosphate receptors; cancer prognosis

Sue A. Shapses, *Associate Professor of Nutritional Sciences, CC; Ph.D., Columbia*
Metabolism of bone and cartilaginous tissue; diet and human metabolism; osteoporosis

Adria R. Sherman, *Professor of Nutritional Sciences, CC; Ph.D., Pennsylvania State*
Trace elements; nutrition and immunity; developmental nutrition

T. Peter Stein, *Professor of Surgery, UMDNJ–SOM; Ph.D., Cornell*
Parenteral nutrition; protein metabolism

Nancy R. Stevenson, *Associate Professor of Physiology, UMDNJ–RWJMS; Ph.D., Rutgers*
Nutrition and GI physiology curricular development

Judith Storch, *Professor of Nutritional Sciences, CC; Ph.D., Columbia*
Cellular lipid transport; structure and function of fatty-acid-binding proteins; gastrointestinal lipid absorption

Beverly J. Tepper, *Associate Professor of Food Science, CC; Ph.D., Tufts*
Regulation of food intake; cognitive factors in food choice; taste perception; changes in taste in disease

T.J. Thomas, *Associate Professor of Medicine, UMDNJ–RWJMS; Ph.D., Indian Institute of Science*
Regulation of ornithine decarboxylase in autoimmune disease; phytochemicals and carcinogenesis
Malcolm Watford, *Associate Professor of Nutritional Sciences, CC; D.Phil., Oxford*
Glutamine metabolism; regulation of glutaminase gene expression
G. Terence Wilson, *Professor of Psychology, GSAPP; Ph.D., SUNY (Stony Brook)*
Assessment and treatment of weight and eating disorders
James E. Wohlt, *Associate Professor of Animal Sciences, CC; Ph.D., Illinois*
Nutrient requirements for growth and lactation
John Worobey, *Professor of Nutritional Sciences, CC; Ph.D., Pennsylvania State*
Diet and behavior; infant and child nutrition and activity; eating disorders
Chung S. Yang, *Professor of Chemical Biology and Pharmacognosy, EMSP; Ph.D., Cornell*
Mechanisms of cancer prevention by dietary constituents, with particular interest in tea

Associate Members of the Graduate Faculty

Carol Byrd-Bredbenner, *Extension Specialist in Family and Consumer Science, CC; Ph.D., Pennsylvania State*
Nutrition education; health promotion and communication; health literacy
Elaine A. Leventhal, *Associate Professor of Medicine, UMDNJ–RWJMS; M.D., Wisconsin (Madison); Ph.D., Yale*
Geriatrics; chronic and acute illnesses; occult malnutrition in the elderly
Sarah L. Ralston, *Associate Professor of Animal Sciences, CC; Ph.D., V.M.D., Pennsylvania*
Equine clinical nutrition; stress and immune function; aging metabolism
Vincent A. Rifici, *Assistant Professor of Medicine, UMDNJ–RWJMS; Ph.D., Rutgers*
Lipoprotein metabolism and atherosclerosis

Programs

Graduate work in nutrition is supervised by faculty members from the departments of nutritional sciences, animal sciences, food science, human ecology, the Ernest Mario School of Pharmacy, and the University of Medicine and Dentistry of New Jersey (UMDNJ). Areas of specialization include nutritional biochemistry; nutrient regulation of gene expression; nutrition and disease; sociological and behavioral aspects of nutrition; mineral, protein and amino acid, and lipid metabolism; community nutrition; and developmental nutrition.

Applicants are expected to have an undergraduate major in a biological science, chemistry, or other field relevant to advanced training in nutritional sciences. The Graduate Record Examination must be taken. Prerequisites for admission include one year of general chemistry, one year of organic chemistry (or one term of organic chemistry and one term of biochemistry), and 12 additional credits of course work in advanced biology, chemistry, biochemistry, nutrition, food science, physics, or calculus.

The graduate program in nutritional sciences offers an M.S. with basic or applied emphasis and a Ph.D. in nutrition. All students complete course work that includes biochemical, physiological, molecular, and clinical aspects of nutrition. They also take seminars and electives in the advanced life sciences. Students in the applied-emphasis option also pursue advanced courses in community nutrition, public health, epidemiology, and psychology.

A joint program leading to an M.S./D.I. (dietetic internship with the University of Medicine and Dentistry of New Jersey–New Jersey Medical School [UMDNJ–NJMS]) is offered. This program provides students with the scientific knowledge and critical thinking skills to become leaders in the field of dietetics. The program is open only to students who have completed a Didactic Program in Dietetics approved by the Commission on Accreditation/Approval for Dietetics Education. Students must be accepted jointly and enrolled simultaneously in the dietetic internship at UMDNJ–NJMS and the M.S. program at Rutgers.

The M.S. degree requires 24 credits of course work and 6 credits of research, including a thesis. The Ph.D. program requires 34 credits of course work in biochemistry, physiology, and nutrition and 38 credits of research. Candidates for the Ph.D. degree must spend a minimum of 12 consecutive months (two terms and a summer session) in residence and register for at least 24 credits of course work and 6 credits of research. Requests for exceptions to this policy are reviewed by the curriculum committee of the program. There is no language requirement. The master of philosophy degree is available to doctoral candidates.

Graduate Courses

16:709:503. INTRODUCTION TO APPLIED NUTRITION RESEARCH (3)
Pre- or corequisites: 16:709:552,553, and statistics.

16:709:504. (S) SEMINAR IN NUTRITION EDUCATION (3)
Prerequisites: 11:709:400, 401 or equivalent.
Investigation, discussion, and evaluation of current research in nutrition education.

16:709:506. NUTRITIONAL ASPECTS OF DISEASE (3)
Prerequisites: 16:709:552,553.
Advanced study of pathophysiological aspects of disease states and the relation to nutrition.

16:709:515. PRINCIPLES OF NUTRITION RESEARCH (3)
Prerequisites: 16:709:552,553.
Advanced topics in metabolic regulation including principles of experimental design as applied to nutrition research.

16:709:521. (S) COMMUNITY NUTRITION (3)
Prerequisites: 11:709:400, 401, or equivalent.
Study of nutritional aspects of public health service and community agencies, and of programs designed to improve nutritional status of various population groups.

16:709:552,553. NUTRITION: A BIOCHEMICALAND PHYSIOLOGICAL BASIS (4,4)
Prerequisites: 11:115:403; 16:115:511 or equivalent. Required of all students.
Digestion, function, and metabolism of proteins and amino acids, carbohydrates, lipids, minerals, and vitamins. Regulatory mechanisms, developmental changes, and species differences that influence the requirements and metabolism of nutrients. Effect of nutrient supply on metabolism at the molecular, cellular, and systemic levels, including special metabolic needs during growth, reproduction, stress, and senescence in animals and man.

16:709:601,602. NUTRITIONAL SCIENCES SEMINAR (1,2)
Student, faculty, and guest speakers. Student presentation required.

16:709:603,604. ADVANCED STUDIES IN NUTRITION (BA,BA)

16:709:621. ADVANCED TOPICS: METABOLIC REGULATION (1)
Prerequisites: 16:709:552,553.
Informal, critical discussion and directed study of current literature and concepts in nutrient metabolism.

16:709:622. ADVANCED TOPICS IN MINERAL NUTRITION (1)
Prerequisites: 16:709:552,553.
Informal, critical discussion and directed study of current literature and concepts in mineral nutrition.

16:709:623. ADVANCED TOPICS: MOLECULAR NUTRITION (1)
Prerequisites: 16:709:552,553.
Informal, critical discussion and directed study of current literature and concepts in the nutritional control of gene expression.

16:709:624. ADVANCED TOPICS IN NUTRITIONAL SCIENCES (1)
Prerequisites: 16:709:552,553.
Informal, critical discussion and directed study in current areas of nutrition research.

16:709:625. RECENT ADVANCES IN NUTRITIONAL SCIENCES (1)
Prerequisites: 16:709:552,553, or permission of instructor.
Informal, critical discussion and directed study in nutritional sciences, ranging from specialized research approaches and techniques to aspects of national and international nutrition policy.

16:709:687,688. INDEPENDENT STUDIES IN NUTRITIONAL SCIENCES (3,3)

16:709:701,702. RESEARCH IN NUTRITIONAL SCIENCES (BA,BA)

OCEANOGRAPHY 712

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Dale Haidvogel, Marine**
Sciences Building, Cook Campus (732/932-6555)
Associate Director: **Professor Gary Taghon, Marine Sciences**
Building, Cook Campus (732/932-6555)
Email: *gpo@imcs.rutgers.edu*
Web Site: *http://marine.rutgers.edu/gpo/GradProg.html*

Members of the Graduate Faculty

Kenneth W. Able, *Professor of Marine and Coastal Sciences, CC; Ph.D., William and Mary*
Ecology and behavior of fishes

Gail M. Ashley, *Professor of Geological Sciences, FAS–NB; Ph.D., British Columbia*
Sedimentology; geomorphology; environmental ecology; modern processes

Robert J. Chant, *Assistant Professor of Marine and Coastal Sciences, CC; Ph.D., SUNY (Stony Brook)*
Observations and numerical modeling of estuarine and coastal processes

Colomban de Vargas, *Assistant Professor of Marine and Coastal Sciences, CC; Ph.D., Geneva*
Molecular ecology and evolution of unicellular organisms in the ocean

Paul G. Falkowski, *Professor of Geological Sciences and Marine and Coastal Sciences, FAS–NB; Ph.D., British Columbia*
Biogeochemical cycles; evolution; astrobiology

Scott M. Glenn, *Professor of Marine and Coastal Sciences, CC; Sc.D., Massachusetts Institute of Technology/Woods Hole Oceanographic Institution*
Physical oceanography; satellite remote sensing

J. Frederick Grassle, *Professor of Marine and Coastal Sciences, CC; Ph.D., Duke*
Marine ecology; oceanography

Judith P. Grassle, *Professor of Marine and Coastal Sciences, CC; Ph.D., Duke*
Population genetics; marine benthic ecology

Ximing Guo, *Associate Professor of Marine and Coastal Sciences, CC; Ph.D., Washington (Seattle)*
Research in cytogenetics; genetic manipulation; and genomic mapping in mollus - can aquaculture species

Dale B. Haidvogel, *Professor of Marine and Coastal Sciences, CC; Ph.D., Massachusetts Institute of Technology/Woods Hole Oceanographic Institution*
Physical oceanography; numerical ocean circulation modeling

Lee J. Kerkhof, *Associate Professor of Marine and Coastal Sciences, CC; Ph.D., California (San Diego)/Scripps Institution of Oceanography*
Marine microbiology-molecular biology; microbial population dynamics

Uwe Kils, *Associate Professor of Marine and Coastal Sciences, CC; Ph.D., Kiel*
Behavior and microdistribution of juvenile fish; in situ optics

Richard A. Lutz, *Professor of Marine and Coastal Sciences, CC; Ph.D., Maine*
Marine ecology and paleoecology; shellfish ecology; biology of deep-sea hydrothermal vents

George R. McGhee, *Professor of Geological Sciences, FAS–NB; Ph.D., Rochester*
Marine paleoecology; evolutionary theory; mass extinction

James R. Miller, *Professor of Marine and Coastal Sciences, CC; Ph.D., Maryland*
Air-sea interactions; remote sensing; climate modeling; earth system science

Kenneth G. Miller, Sr., *Professor of Geological Sciences, FAS–NB; Ph.D., Massachusetts Institute of Technology/Woods Hole Oceanographic Institution*
Cenozoic stratigraphy and paleoceanography; integrated biostratigraphy, isotope stratigraphy, magnetostratigraphy, and seismic stratigraphy

Michael R. Muller, *Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Brown*
Fluid mechanics; internal gravity waves and thermals

Karl F. Nordstrom, *Professor of Marine and Coastal Sciences, CC; Ph.D., Rutgers*
Geomorphology; sedimentology

Richard K. Olsson, *Professor Emeritus of Geological Sciences, FAS–NB; Ph.D., Princeton*
Micropaleontology; stratigraphy; paleoecology; paleobathymetry of Cretaceous and Cenozoic formations

Eric N. Powell, *Professor of Marine and Coastal Sciences, CC; Ph.D., North Carolina (Chapel Hill)*
Shellfish biology/modeling, carbonate preservation, reproductive biology

Norbert P. Psuty, *Professor Emeritus of Marine and Coastal Sciences, CC; Ph.D., Louisiana State*
Coastal geomorphology; shoreline erosion; coastal zone management

John A. Quinlan, *Assistant Professor of Marine and Coastal Sciences, CC; Ph.D., North Carolina (Chapel Hill)*
Fisheries oceanography, management, biophysical interactions, modeling

John R. Reinfelder, *Associate Professor of Environmental Sciences, CC; Ph.D., SUNY (Stony Brook)*
Trace element biogeochemistry; phytoplankton physiology and marine primary production; marine carbon cycle

Alan Robock, *Professor of Environmental Sciences, CC; Ph.D., Massachusetts Institute of Technology*
Climatological data analysis; climate modeling; impacts of climate change; soil; moisture; remote sensing

Peter A. Rona, *Professor of Geological and Marine and Coastal Sciences, CC; Ph.D., Yale*
Structure and evolution of continental margins and ocean basins; ocean ridges and seafloor hydrothermal processes

Yair Rosenthal, *Assistant Professor of Geological Sciences and Marine and Coastal Sciences, CC; Ph.D., Massachusetts Institute of Technology/Woods Hole Oceanographic Institution*
Biogeochemistry; paleoceanography

Oscar M.E. Schofield, *Associate Professor of Marine and Coastal Sciences, CC; Ph.D., California (Santa Barbara)*
Marine phytoplankton ecology; bio-optics; effects of ultraviolet radiation on phytoplankton

Sybil P. Seitzinger, *Visiting Professor of Marine and Coastal Sciences, CC; Ph.D., Rhode Island*
Nutrient dynamics in marine, freshwater, and terrestrial ecosystems

Robert E. Sheridan, *Professor of Geological Sciences, FAS–NB; Ph.D., Columbia*
Geology and geophysics of the Atlantic continental margin

Robert M. Sherrell, *Associate Professor of Geological Sciences and Marine and Coastal Sciences, CC; Ph.D., Massachusetts Institute of Technology/Woods Hole Oceanographic Institution*
Trace metals in the oceanic water column; environmental chemistry

Peter Smouse, *Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., North Carolina State*
Genetics and ecology

Gary L. Taghon, *Associate Professor of Marine and Coastal Sciences, CC; Ph.D., Washington (Seattle)*
Marine benthic ecology

Christopher G. Uchrin, *Professor of Environmental Sciences, CC; Ph.D., Michigan*
Mathematical modeling of contaminant transport in surface and ground waters

Costantino Vetriani, *Assistant Professor of Biochemistry and Microbiology and Marine and Coastal Sciences, CC; Ph.D., Rome*
Deep-sea microbiology, thermophiles, microbial adaptations to extreme environments

John L. Wilkin, *Assistant Professor of Marine and Coastal Sciences, CC; Ph.D., Massachusetts Institute of Technology/Woods Hole Oceanographic Institution*
Physical oceanography, coastal dynamics, coupled physical/biological modeling

Associate Members of the Graduate Faculty

James W. Ammerman, *Associate Research Professor of Marine and Coastal Sciences, CC; Ph.D., California (San Diego)/Scripps Institute of Oceanography*
Aquatic (especially marine and estuarine) microbial ecology and biochemistry

Richard H. Dunk, *Adjunct Professor of Environmental Sciences, CC; Ph.D., Rutgers*
Meteorology, air-sea interactions, sea breezes

Jennifer A. Francis, *Assistant Research Professor of Marine and Coastal Sciences, CC; Ph.D., Washington*
Satellite remote sensing of polar regions; air/ice/ocean energy transfer

Michael Kennish, *Assistant Research Professor, CC; Ph.D., Rutgers*
Marine geology; estuarine and marine ecology; marine pollution

Elisabeth L. Sikes, *Associate Research Professor of Marine and Coastal Sciences, CC; Ph.D., Massachusetts Institute of Technology/Woods Hole Oceanographic Institution*
Paleoceanography, marine organic geochemistry

Adjunct Member of the Graduate Faculty

Michael P. Weinstein, *Visiting Professor of Marine and Coastal Sciences, CC; Ph.D., Florida State*
Coastal ecology; habitat utilization (nekton); secondary production; restoration ecology; ecological engineering

Programs

The program has a diverse faculty representing the major oceanographic disciplines: physical, biological, and chemical oceanography, geology and geophysics, and engineering. The faculty are all members of the Institute of Marine and Coastal Sciences, established in 1989 to foster interdisciplinary research and coordinate Rutgers' marine and coastal programs.

The M.S. and Ph.D. degrees are offered in physical oceanography, biological oceanography, chemical oceanography, and marine geology. Preference in admission is given to candidates seeking a Ph.D. Applicants are required to demonstrate a commitment to interdisciplinary studies, including study of the physical and dynamical behavior of ocean systems. Applicants to the physical oceanography sequence are expected to hold an undergraduate degree in mathematics, physical science, or engineering. They also must have completed two years of calculus (through differential equations) and one year each of physics and chemistry. Applicants in biological oceanography are expected to hold an undergraduate degree in one of the biological sciences and have successfully

completed courses (one year each) in calculus, physics, general chemistry, and organic chemistry. Applicants in chemical oceanography are expected to hold an undergraduate degree in chemistry and have successfully completed courses (one year each) in calculus, physics, organic chemistry, and physical chemistry.

The Ph.D. requires a minimum of 72 credits of work beyond the bachelor's degree, including a minimum of 42 credits of Ph.D. thesis research. Qualifying examinations for the doctorate include written and oral components. A typical program of course work includes graduate-level courses within the Department of Marine and Coastal Sciences and related courses offered by other graduate programs, such as ecology and evolution, environmental sciences, mechanical and aerospace engineering, and atmospheric sciences.

Research opportunities are available in a range of marine and coastal topics, including applied genetics and evolution, biogeochemistry, bottom boundary-layer studies, coastal processes, community ecology, ecosystem-level studies, larval transport and recruitment, marine genetics, nutrient cycling, observing systems and operational oceanography, ocean modeling, physical oceanography, population biology, remote sensing, systematics, fish biology, and fisheries oceanography.

A state-of-the-art research building on the Cook College campus includes a seawater flume, morphometrics, molecular biology, remote-sensing, and ocean modeling laboratories. Institute faculty and students have access to novel ocean observing system facilities including a satellite receiving station, a regional set of high-frequency coastal radars, and a growing fleet of gliders and autonomous vehicles. The institute's resources also include a network of small, medium, and large computer platforms with approximately 80 IBM and Mac PC systems, 30 Unix-based workstations, and three multiprocessor parallel computing platforms.

In addition to the central campus in New Brunswick, research opportunities are provided at three field stations. The Rutgers University Marine Field Station, located at the northern entrance to Great Bay, is the site of a large tract of pristine marsh and a major estuary that retains most of its natural characteristics. An extensive program of long-term oceanographic and ecosystem research is underway at the station. Long-term ecosystem observatory sites (LEOs) have been established on the continental shelf, slope, and rise in conjunction with the New York Bight National Undersea Research Center. One of these sites (LEO-15) is connected to the Marine Field Station by electric/fiber optic cable, providing power and two-way communications with a variety of in situ sensors.

The Rutgers University Haskin Shellfish Research Laboratory, located on Delaware Bay, has small boats and docking facilities. Research areas include microbiology, histopathology, shell structure, shellfish physiology, shellfish pathophysiology, analytical chemistry, cytogenetics, and biochemistry/physiology. Rutgers University Pineland Research Station, in Lebanon State Forest, is located near New Lisbon in the Pinelands National Reserve. It provides ready access to a diversity of upland and wetland habitats.

Graduate Courses

16:712:501. (F) PHYSICAL OCEANOGRAPHY (3)
Chant, Miller, Wilkin. Prerequisites: One year of college calculus and college physics.
Physical properties and basic equations for describing waves, tides, currents, and the large-scale wind-driven and thermohaline circulation. Ekman, geostrophic, and inertial flows. Gulf Stream; air-sea interactions; El Niño.

16:712:502. (F) LARGE-SCALE OCEAN AND ATMOSPHERE DYNAMICS (3)
Haidvogel. Prerequisite: 16:712:501 or permission of instructor. Offered in alternate years.
Observational basis for large-scale ocean circulation; derivation of oceanic equations of motion; Kelvin, planetary, and topographic waves; wind-driven ocean circulation; simple models of abyssal circulation and thermocline; instabilities and mesoscale eddies.

16:712:503. (S) COASTAL OCEAN DYNAMICS (3)
Haidvogel, Wilkin. Prerequisite: 16:712:501 or 502. Offered in alternate years.
Observation basis and theoretical foundation of coastal ocean dynamics; tides; rotation; Kelvin and vorticity waves; fronts and plumes; upwelling; estuaries and buoyancy forcing; effects of boundaries and topography; biogeochemical implications.

16:712:521. (S) MARINE BENTHIC ECOLOGY (3)
Taghon. Prerequisites: One year of college calculus and invertebrate zoology. Offered in alternate years.
Emphasis on fauna living in soft sediments: roles in nutrient cycling and marine food webs; feeding biology, reproduction, and recruitment; community structure as influenced by physical and chemical properties of the environment.

16:712:522. (S) BIOLOGICAL OCEANOGRAPHY (3)
Taghon. Prerequisite: One year of college biology.
Interactions among biological, physical, and chemical components of the marine environment, including primary production and secondary production, biogeochemical cycles, food web interactions, and ecosystem analysis of selected marine ecosystems. Habitats considered include the open ocean, coastal waters, kelp beds, coral reefs, estuaries, the deep sea, and hydrothermal vent environments.

16:712:523. (F) PRIMARY PRODUCTION IN AQUATIC ECOSYSTEMS (3)
Schofield. Prerequisite: Permission of instructor. Offered in alternate years.
Regulation of phytoplankton productivity in nature; physiological ecology of phytoplankton in dynamic environments; impact of phytoplankton on water column optical and chemical properties; new technologies being used in fieldwork.

16:712:524. EARLY LIFE HISTORY OF FISH (3)
Able. Prerequisite: Ichthyology or permission of instructor. Offered in alternate years.
The phylogeny, morphology, life history, ecology, and behavior of fish during the egg, larval, and juvenile stages. Detailed treatments of representative estuarine marine and freshwater fish.

16:712:540. (F) CHEMICAL OCEANOGRAPHY (3)
Prerequisites: One year of college chemistry; 16:712:501.
Chemical description of the ocean and its major chemical cycles; salinity and the elements of seawater; nutrients; the carbonate system; marine organic matter; radioisotopes; hydrothermal processes and ocean evolution.

16:712:545. (S) DYNAMICS OF WAVES, CURRENTS, AND SEDIMENT TRANSPORT ON THE CONTINENTAL SHELF (3)
Glenn. Prerequisite: 16:712:501. Offered in alternate years.
Equations of motion; linear theory for surface waves, wave boundary layers; current Ekman layers, coastal current circulation patterns; sediment transport in steady flow, oscillatory flow, and combined waves and currents.

16:712:552. (S) REMOTE SENSING OFTHE OCEANAND ATMOSPHERE (3)
Francis, Miller, Wilkin. Prerequisite: One year of physics.
Introduction to physical principles of remote sensing; past, present, and future instruments on satellites, aircraft, the surface, and under the ocean; applications in oceanography and atmospheric sciences.

16:712:560. (F) HISTORY OF THE EARTH SYSTEM (3)
Falkowski. Prerequisites: Introductory chemistry, biology, and physics, or permission of instructor.
Introduction to major processes that have shaped Earth's environment, including climatic processes on geological time scales, the evolution of organisms, the cycling of elements, and the feedback between these processes.

16:712:591. (S) SPECIAL TOPICS: MARINE ECOSYSTEMS RESEARCH (BA)
Noji, Quinlan
Drawing heavily on the experience of NOAAfisheries scientists, this interdisciplinary course focuses on the importance of habitat and species characteristics in determining the distribution and success of economically important marine and estuarine fish occurring along the northeast coast of the United States. Topics covered include habitat requirements and assessment, gear effects, contaminants, recruitment processes, and life history.

16:712:603. (F) NUMERICAL MODELING OF THE ATMOSPHERE AND OCEAN I (3)
Haidvogel. Prerequisites: 16:375:547, 16:712:502, or equivalent; proficiency in a high-level programming language. Offered in alternate years.
Governing equations of atmospheric/oceanic motion; simplification and scaling; parameterization issues; numerical solution of the equations; Fourier and spectral methods; evaluation of atmospheric and oceanic models.

16:712:604. (S) NUMERICAL MODELING OF THE ATMOSPHERE AND OCEAN II (3)
Haidvogel. Offered in alternate years.
Laboratory course for practical application of numerical approaches taught in 16:712:603, including literature review, problem formulation, model development, and synthesis and presentation of results.

16:712:615. (S) GEOPHYSICAL DATA ANALYSIS (3)
Chant, Wilkin. Prerequisites: Calculus, differential equations, linear algebra.
Quantitative analysis and display of spatial and time series data; filters; spectral analysis; covariance; coherence; confidence intervals; goodness-of-fit; optimal interpolation of unequally spaced data; empirical orthogonal functions; harmonic analysis. Practical exercises using Matlab to analyze data from marine and environmental instruments, satellites, and climatologies. Communicating quantitative results to an audience.

16:712:693,694. INDEPENDENT STUDY IN OCEANOGRAPHY (BA,BA)

16:712:695,696. SPECIAL PROBLEMS IN OCEANOGRAPHY (BA,BA)

16:712:697,698. TOPICS IN OCEANOGRAPHY (BA,BA)

16:712:701-702. RESEARCH IN OCEANOGRAPHY (BA,BA)

OPERATIONS RESEARCH 711

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Peter L. Hammer,**
Center for Operations Research, RUTCOR Building, Brett and Bartholomew Roads, Busch Campus (732/445-4812)

Members of the Graduate Faculty

Susan L. Albin, *Professor of Industrial and Systems Engineering, SE; D.E.Sc., Columbia*
Queuing; simulation; quality control and reliability

Farid Alizadeh, *Assistant Professor of Management Science and Information Systems, RBS; Ph.D., Minnesota*
Combinatorial optimization; convex programming; computational biology

Tayfur Altiok, *Professor of Industrial and Systems Engineering, SE; Ph.D., North Carolina State*
Production lines; production/inventory systems; queuing networks

Ronald D. Armstrong, *Professor of Management Science, RBS/RUTCOR; Ph.D., Massachusetts*
Network theory, integer programming and applications

Benjamin Avi-Itzhak, *Professor of Management and Operations Research, RBS/RUTCOR; D.Sc., Israel Institute of Technology*
Stochastic models in operations research

Adi Ben-Israel, *Professor of Operations Research, RBS/RUTCOR; Ph.D., Northwestern*
Matrix theory; convexity and optimization; mathematical programming; mathematical economics

Douglas H. Blair, *Professor of Economics, RBS/RUTCOR; Ph.D., Yale*
Microeconomic theory; social choice theory

Endre Boros, *Professor of Operations Research, RUTCOR/RBS; Ph.D., Budapest*
Discrete and combinatorial optimization; integer programming

Michael Lee Bushnell, *Professor of Electrical and Computer Engineering, SE; Ph.D., Carnegie Mellon*
VLSI design; testing of logic circuits; computer-aided design

Vašek Chvátal, *Professor of Computer Science, FAS–NB; Ph.D., Waterloo*
Algorithms; combinatorics; graph theory; operations research

Jonathan Eckstein, *Associate Professor of Management Science and Information Systems, RBS/RUTCOR; Ph.D., Massachusetts Institute of Technology*
Mathematical programming; parallel computing; convex analysis; proximal methods; applied combinatorial optimization

Michael R. Greenberg, *Professor of Urban Planning and Public Health, EJBSPPP; Ph.D., Columbia*
Environmental planning; public health

Michael D. Grigoriadis, *Professor of Computer Science, FAS–NB; Ph.D., Wisconsin*
Algorithms for network optimization

Peter L. Hammer, *Professor of Mathematics and Computer Science Management and Director of the Center for Operations Research, RUTCOR/RBS; Ph.D., Bucharest*
Boolean methods in operations research; discrete optimization

Ronald Harstad, *Associate Professor of Management, RBS; Ph.D., Pennsylvania*
Game theory; laboratory economics; auctions

Stephen J. Herschkorn, *Assistant Professor of Management Science and Information Systems, RBS/RUTCOR; Ph.D., California (Berkeley)*
Sequential decision making under uncertainty; stochastic modeling; stochastic optimization

Alan Hoffman, *Visiting Professor of Mathematics, RUTCOR; Ph.D., Columbia*
Combinatorics and optimization; linear algebra

Douglas H. Jones, *Associate Professor of Management, RBS; Ph.D., Florida State*
Psychometrics; integer programming applications to test construction; optimal experimental design; Bayesian methods; optimal financial portfolios

Jeffry N. Kahn, *Professor of Mathematics, FAS–NB; Ph.D., Ohio State*
Matroids; extremal problems in set theory and graph theory; finite geometries

Paul Kantor, *Professor of Library and Information Studies, SCILS; Ph.D., Princeton*
Information and decision systems; information economics; library and information systems evaluation; system interfaces

Michael N. Katehakis, *Associate Professor of Management, RBS; Ph.D., Columbia*
Dynamic programming reliability; queuing; sequential statistics; operations management

Leonid Khachiyan, *Professor of Computer Science, FAS–NB; Ph.D., USSR Academy of Sciences*
Mathematical programming; complexity; discrete optimization

Alexander Kogan, *Associate Professor of Accounting and Information Systems, RBS/RUTCOR; Ph.D., USSR Academy of Sciences*
Expert systems; logical analysis of data; Boolean functions; combinatorial optimization; information systems

Cheng-few Lee, *Professor of Finance, RBS; Ph.D., SUNY (Buffalo)*
Applying econometrics and economic theory in finance and accounting research

Lei Lei, *Assistant Professor of Management Science, RBS; Ph.D., Wisconsin (Madison)*
Vehicle scheduling and cyclic scheduling; convex resource allocation and production planning algorithms

Richard McLean, *Associate Professor of Economics, FAS–NB; Ph.D., SUNY (Stony Brook)*
Game theory and its applications

Benjamin Melamed, *Professor of Management Science and Information Systems, RBS/RUTCOR; Ph.D., Michigan*
Stochastic processes; modeling and simulation; telecommunications modeling; programming languages

Joseph I. Naus, *Chairperson and Professor of Statistics, FAS–NB; Ph.D., Harvard*
Applied probability; data quality control; clustering

Rosa Oppenheim, *Professor of Operations Research, RBS; Ph.D., Polytechnic Institute of Brooklyn*
Mathematical programming; graph theory; forecasting

Andras Prekopa, *Professor of Operations Research and Statistics, FAS–NB; Ph.D., Budapest*
Stochastic processes; stochastic optimization; linear and nonlinear programming; inventory control; applications to engineering design

Fred S. Roberts, *Professor of Mathematics, FAS–NB, and Director of the Center for Discrete Mathematics and Theoretical Computer Science (DIMACS); Ph.D., Stanford*
Discrete mathematical models; graph theory; decision making; measurement theory

Michael H. Rothkopf, *Professor of Management and Operations Research, RBS/RUTCOR; Ph.D., Massachusetts Institute of Technology*
Practice of operations research; models of bidding; energy economics

Andrzej Ruszczynski, *Professor of Management Science and Information Systems, RBS/RUTCOR; Ph.D., Warsaw*
Stochastic programming, financial modeling, and risk management

Michael E. Saks, *Associate Professor of Mathematics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Combinatorial optimization and algorithms; extremal set theory; partially ordered sets

Glenn Shafer, *Professor of Management, RBS; Ph.D., Princeton*
Probability in statistical inference; expert systems; causal conjecture
David F. Shanno, *Professor of Management and Operations Research, RBS/RUTCOR; Ph.D., Carnegie Mellon*
Linear and nonlinear programming; numerical analysis; parallel computing
Eduardo D. Sontag, *Professor of Mathematics, FAS–NB; Ph.D., Florida*
System and control theory
William L. Steiger, *Professor of Computer Science, FAS–NB; Ph.D., Australian National*
Algorithms; parallel computations; computational geometry
William E. Strawderman, *Professor of Statistics, FAS–NB; Ph.D., Rutgers*
Decision theory; inference; multivariate statistics
Hector J. Sussmann, *Professor of Mathematics, FAS–NB; Ph.D., New York*
System and control theory
Hiroki Tsurumi, *Professor of Economics, FAS–NB; Ph.D., Pennsylvania*
Bayesian econometrics and statistical inference
Yehuda Vardi, *Professor of Statistics, FAS–NB; Ph.D., Cornell*
Stochastic modeling; applied probability; statistical theory and methods
Robert Vichnevetsky, *Professor of Computer Science, FAS–NB; Ph.D., Brussels*
Numerical analysis; modeling and simulation of systems
Charles A. Weibel, *Professor of Mathematics, FAS–NB; Ph.D., Harvard*
Algebraic K-theory; homological algebra; algebraic topology; category theory

Programs

Operations research is by nature an interdisciplinary field. It has its origins in World War II when scientists, engineers, and mathematicians were asked to develop ways to make the most effective use of limited military resources. Since then, operations research has had a major impact on improving the efficiency of business and government. The discipline has been widely applied to help decision makers allocate scarce resources and to solve problems involving design, allocation, planning, and logistics.

The faculty represented in the program work on a variety of research problems, from the theoretical to the applied. Recent faculty research interests include combinatorial optimization, linear and nonlinear programming, network optimization and synthesis, Boolean functions, integer programming, dynamic programming, graph theory, matroid theory, and artificial intelligence and expert systems. Other faculty members are studying mathematical models of social and policy problems, measurement theory, utility and decision making, social choice, game theory, computational complexity, queuing theory, stochastic processes and stochastic optimization, competitive bidding, statistical decision theory, design and analysis of surveys, random algorithms, economics of uncertainty, natural resources, numerical analysis, simulation, reliability theory, production analysis, inventory theory, scheduling, performance analysis, system theory, dynamic systems, and optimal-control problems.

The Ph.D. program in operations research emphasizes both the theory and the practice of operations research. Doctoral students are exposed to theoretical and computational aspects of operations research and to its applications. They also are expected to specialize by taking a series of courses chosen to complement their individual strengths and interests. Students are encouraged to get involved in the research activities of the Rutgers Center for Operations Research (RUTCOR).

Specific features of the Ph.D. program in operations research include a strong research orientation and emphasis on the interdisciplinary nature of operations research. Many students are authors or coauthors of research reports presented at major conferences and published in internationally circulated journals. The program has a curriculum and faculty drawn from several disciplines. Students are encouraged to take courses from other departments in the mathematical sciences, engineering, business, and other subjects. The program is strong particularly in optimization theory, discrete and stochastic operations research, and logical analysis of data. Additional applications to science, engineering, and finance are being developed.

Students pursuing studies leading to the M.S. degree in operations research prepare for positions in industry and government that apply methods of operations research to practical problems. Students in the M.S. program are encouraged to take as many practically oriented interdisciplinary operations research courses as possible and to participate in various operations research programs at RUTCOR that are aimed at industrial and government applications.

The major requirements for the Ph.D. involve course work (48 credits), research work (24 credits), a Ph.D. qualifying examination, and a dissertation. There also is a seminar requirement.

The major requirements for the M.S. involve course work (30 credits), an essay, and a final examination. The essay can be expository, or it may involve the development of new theoretical results, software, computer implementation of algorithms, modeling, or a related topic. There also is a seminar requirement.

A wide variety of courses related to operations research are given by the programs participating in RUTCOR and other departments at the university. In addition, students in the Ph.D. and M.S. programs may sign up for independent study courses for credit toward the 48-credit or 30-credit requirements. All students are expected to participate extensively in RUTCOR's seminars and colloquia.

Admission to the M.S. and Ph.D. programs is awarded selectively by the admissions committee. Applicants to the M.S. program should have an undergraduate degree in a field related to operations research. Applicants to the Ph.D. program should have either a bachelor's or a master's degree in one of these fields. Both programs, which are intended to be small, are aimed at a high-quality group of students. Applications should include transcripts, three letters of recommendation, and scores from the Graduate Record Examination. A subject test in a field related to operations research is recommended but not necessary. Foreign students should supply a score on the TOEFL. The official deadline for application is May 1, although this deadline is waived whenever possible for qualified students.

Students entering the programs in operations research are expected to have knowledge of undergraduate probability, statistics, advanced calculus, linear algebra, and introductory computer science.

Financial support for graduate study in operations research at Rutgers is coordinated through RUTCOR. Students are supported through teaching, graduate and research assistantships in the participating departments of RUTCOR or in RUTCOR itself, research on faculty members' research projects, fellowships, and adjunct teaching jobs. Applications for financial support should be included with the application for admission. They are due by March 1 for the following academic year (beginning in September). Late applications for financial support are accepted as long as support is available.

Graduate Courses

16:711:513. (S) DISCRETE OPTIMIZATION (3)
Prerequisite: 16:198:521 or equivalent.
Develops the mathematical foundation of linear and nonlinear optimization procedures for problems in which the variables can take on values only in a finite set, usually (0,1). A variety of algorithms are presented, along with numerous applications.

16:711:517. (F) COMPUTATIONAL PROJECTS IN OPERATIONS RESEARCH (3)
Staff. Prerequisite: 01:640:350 or 354.
Individual and group assignments; intensive computer practice; coding; programming.

16:711:525. (S) STOCHASTIC MODELS OF OPERATIONS RESEARCH (3)
Staff. Prerequisites: 01:640:477 or 16:960:654.
Overview of stochastic operations research model construction. Elements of queuing theory. Stochastic models of inventory and production control. Reliability models. Models in stochastic and dynamic programming. Stochastic simulation and its use in operations research.

16:711:531. (F) ACTUARIAL MATHEMATICS (3)
Prekopa. Prerequisite: 01:960:381.
Economics of insurance, life tables, life insurance, life annuities, benefit premiums and reserves, multiple-life theory, multiple-decrement models, risk theory, and population theory.

16:711:547,548. Case Studies in Applied Operations Research (3,3)
Prerequisites: Linear programming, probability, and computer programming.
Applications in operations research. Investigates the modeling process as it deals with economic uncertainties, missing information, risk, and priorities. Case study approach used, with students writing "recommendation to management" reports. Guest lecturers from industry describe actual projects.

16:711:553. Boolean and Pseudo-Boolean Functions (3)
Prerequisite: Permission of instructor. Recommended: 16:198:521, 16:642:581, or equivalent.
Theory and applications of Boolean functions and of set (or pseudo-Boolean) functions. Important classes of such functions (e.g., threshold functions) examined. Applications to graph theory, integer programming, and decision making.

16:711:555. (F) Stochastic Programming (3)
Prekopa. Prerequisites: 16:198:521, 01:640:477.
Decision principles in stochastic programming: penalty models, probabilistic constrained models, dynamic type models. Convexity theory and solutions of the relevant optimization problems by mathematical programming techniques. Applications in economics, business, and engineering.

16:711:556. (S) Queuing Theory (3)
Avi-Itzhak. Prerequisite: 16:960:680.
Review of major properties of stochastic processes and Markovian-type queues. General theorems in the theory of queues. M/G/1 type systems. Priority disciplines. Conservative queues. Lindley's model. Ordering and monotonicity. Bounds and approximations. Tandem queues. Reversibility, symmetry, and networks. Applications.

16:711:601,602. Seminar in Operations Research (0,0)
Prerequisite: Permission of instructor.
Regular participation in the colloquia and seminars run by RUTCOR required of all M.S. and Ph.D. students.

16:711:611,612,613,614. Selected Topics in Operations Research (BA,BA,BA,BA)
Prerequisite: Permission of instructor.
Topics of current interest relevant to operations research.

16:711:631. (S) Financial Mathematics II (3)
Prekopa. Prerequisites: 16:198:521, 01:960:381.
Options, futures and other derivatives, arbitrage pricing, Black-Scholes theory, exotic options, interest-rate models, stochastic programming models, and their applications to financial planning.

16:711:695,696,697,698,699. Independent Study in Operations Research (BA,BA,BA,BA,BA)
Focuses on a specialized topic in operations research individually designed with a supervising faculty member.

16:711:701,702. Research in Operations Research (BA,BA)

See also courses listed under computer science, economics, industrial and systems engineering, statistics, and mathematics (applied mathematics), and in the doctoral program in management at the Graduate School–Newark, including the following courses:

16:198:503. Data Structures and Algorithms (3)

16:198:510. Numerical Analysis (3)

16:198:513, 514. Design and Analysis of Data Structures and Algorithms I,II (3,3)

16:198:521. Linear Programming (3)

16:198:522. Network and Combinatorial Optimization Algorithms (3)

16:198:524. Nonlinear Programming Algorithms (3)

16:198:526. Advanced Numerical Analysis (3)

16:198:528. Parallel Numerical Computing (3)

16:198:535. Pattern Recognition Theory and Applications (3)

16:198:538. Complexity of Computation (3)

16:198:541. Database Systems (3)

16:220:500. Mathematical Methods for Microeconomics (3)

16:220:501, 502. Microeconomic Theory I,II (3,3)

16:220:503. Mathematical Methods for Macroeconomics (3)

16:220:507, 508. Econometrics I,II (3,3)

16:220:545. Uncertainty and Imperfect Information (3)

16:220:546. Topics in Game Theory (3)

26:390:571. Survey of Financial Theory (3)

26:390:662. Investment Analysis and Portfolio Theory (3)

16:540:510. Deterministic Models in Industrial Engineering (3)

16:540:515. Stochastic Models in Industrial Engineering (3)

16:540:520. Supply Chain and Logistics Engineering (3)

16:540:530. Forecasting and Time Series Analysis (3)

16:540:555. Simulation of Production Systems (3)

16:540:560. Production Analysis (3)

16:540:565. Facilities Planning and Design (3)

16:540:568. Automation and Computer-Integrated Manufacturing (3)

16:540:585. System Reliability Engineering (3)

16:540:655. Performance Analysis of Manufacturing Systems (3)

16:540:660. Inventory Control (3)

16:540:665. Theory of Scheduling (3)

16:642:573,574. Numerical Analysis (3,3)

16:642:577,578. Selected Mathematical Topics in System Theory (3,3)

16:642:581. Graph Theory (3)

16:642:582,583. Combinatorics I,II (3,3)

16:642:585. Mathematical Models of Social and Policy Problems (3)

16:642:586. Theory of Measurement (3)

16:642:587. Selected Topics in Discrete Mathematics (3)

16:642:588. Introduction to Mathematical Techniques in Operations Research (3)

16:642:589. Topics in Mathematical Techniques in Operations Research (3)

26:711:561. Introduction to Mathematical Economics (3)

26:711:585. Control Models in Operations Management (3)

26:711:586. Planning Models in Operations Management (3)

26:711:652. Nonlinear Programming (3)

26:711:676. Statistical Aspects of Stochastic Simulation (3)

16:960:540, 541. Statistical Quality Control I,II (3,3)

16:960:542. Life Data Analysis (3)

16:960:563. Regression Analysis (3)

16:960:567. Applied Multivariate Analysis (3)

26:960:580. Stochastic Processes (3)

16:960:586, 587. Interpretation of Data I,II (3,3)

16:960:590. Design of Experiments (3)

16:960:591. Advanced Design of Experiments (3)

16:960:593. Theory of Statistics (3)

16:960:652, 653. ADVANCED THEORY OF STATISTICS I,II (3,3)

16:960:654. STOCHASTIC PROCESSES (3)

16:960:663. REGRESSION THEORY (3)

16:960:680, 681. ADVANCED PROBABILITY THEORY I,II (3,3)

16:960:689. SEQUENTIAL METHODS (3)

PACKAGING SCIENCE AND ENGINEERING

Programs

Academic and research training in the area of packaging science and engineering for master's candidates is available at Rutgers in the following programs of the Graduate School–New Brunswick: ceramic science and engineering, food science, industrial and systems engineering, materials science and engineering, and pharmaceutical science.

Degree requirements are set in accordance with the student's graduate program. The student electing this option enrolls in an interdisciplinary program that includes core courses in business, science, and engineering and a concentration in one of the six participating disciplines. Coordination among the five faculties sponsoring the packaging option provides maximum flexibility and variety in the arrangement of individual degree programs.

For a master of science degree, a student must be admitted to, and meet the requirements of, one of the following programs of the Graduate School–New Brunswick: ceramic science and engineering, food science, industrial and systems engineering, mechanics and materials science, or pharmaceutical science. This program requires a minimum of 18 credits involving courses in the degree program unrelated to packaging. The student also must meet the following common core requirements: the courses in packaging engineering, 16:150:571,572; the seminars in packaging, 16:150:581,582; the materials and design in packaging courses, 16:150:577,578; and either the special problems in packaging courses, 16:150:587,588, or the research thesis on packaging as approached through the departmental specialization.

The interaction of packaging and the environment is a broad subject of common concern underlying all programs that feature the option in packaging. Within this area, students are expected initially to indicate which one of the following three concentrations they wish to explore: packaging science and technology, packaging and production engineering, or packaging and marketing/management. For further information, the interested student should contact the director of one of the above programs or Professor James D. Idol, School of Engineering, Busch campus (732/445-3224).

PHARMACEUTICAL SCIENCE 720

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Ah-Ng Tony Kong, Ernest Mario School of Pharmacy, William Levine Hall, Busch Campus (732/445-3831, ext. 226)**

Members of the Graduate Faculty in the Pharmaceutical Science

John L. Colaizzi, *Professor of Pharmacy and Dean of the Ernest Mario School of Pharmacy; Ph.D., Purdue*
Applied pharmacokinetics and biopharmaceutics
Allan H. Conney, *Professor and Director of Laboratory for Cancer Research, EMSP; Ph.D., Wisconsin*
Cytochromes P-450 and drug metabolism; chemical carcinogenesis
Thomas J. Cook, *Assistant Professor of Pharmaceutics, EMSP; Ph.D., Michigan*
Drug/vaccine delivery systems, mechanisms of drug/antigen transport
Gregory T. Knipp, *Assistant Professor of Pharmaceutics, EMSP; Ph.D., Kansas*
Drug transport and delivery
Joachim Kohn, *Professor of Chemistry, FAS–NB; Ph.D., Weizmann Institute*
Tissue engineering and biomaterials, development of new degradable polymers
Ah-Ng Tony Kong, *Professor of Pharmaceutical Science, EMSP; Ph.D., SUNY (Buffalo)*
Cancer preventive agents; pharmacokinetics; pharmacodynamics and pharmacogenomics

Nicholas G. Lordi, *Professor Emeritus of Pharmaceutics, EMSP; Ph.D., Purdue*
Pharmaceutics
Bozena Michniak, *Laboratory for Drug Delivery, New Jersey Center for Biomaterials, Newark; Ph.D., Leicester Polytechnic*
Topical and transdermal drug delivery
Tamara Minko, *Associate Professor of Pharmaceutics, EMSP; Ph.D., Ukrainian Academy of Science*
Patrick J. Sinko, *Chairperson and Professor of Pharmaceutics, EMSP; Ph.D., Michigan*
Biopharmaceutics; intestinal absorption mechanism; peptide drug analogs and anti-HIV drug metabolism
Dong-Churl Suh, *Associate Professor of Pharmaceutical Economics, EMSP; Ph.D., Minnesota*
Pharmaceutical economics, cost effectiveness, outcomes assessment, prescription drug benefits policy, and pharmaceutical pricing
Kathryn Uhrich, *Associate Professor of Chemistry, FAS–NB; Ph.D., Cornell*
Design, synthesis, and characterization of novel organic polymers for medicinal use
Chung S. Yang, *Chairperson and Professor of Pharmacognosy, EMSP; Ph.D., Cornell*
Carcinogenesis, chemoprevention and pharmacokinetic and bioavailability studies
Guofeng You, *Associate Professor of Pharmaceutics, EMSP; Ph.D., Clark*
Cellular and molecular mechanisms of drug transport
Joel L. Zatz, *Professor of Pharmaceutics, EMSP; Ph.D., Columbia*
Pharmaceutics, percutaneous absorption and topical drug delivery

Associate Members of the Graduate Faculty in the Pharmaceutics Track

Albert Cuitiño, *Associate Professor of Mechanical and Aerospace Engineering, SE; Ph.D., Brown*
Computational solid mechanics
Fernando Muzzio, *Professor of Chemical and Biochemical Engineering, SE; Ph.D., Massachusetts (Amherst)*
Mixing; chaos and randomness; transport phenomena

Programs

The program offers courses leading to the master of science and doctor of philosophy degrees in pharmaceutical science. Most applicants have undergraduate degrees in biochemistry, biology, chemistry, pharmaceutical science, or other physical or biological sciences. Pharmaceutics areas of research include drug delivery, controlled drug release technology, design of new biomaterials, biopharmaceutics, metabolism, and percutaneous drug absorption. Degree requirements for the M.S. degree include a minimum of 24 credits of course work and completion of an original research problem and thesis (6 credits).

The Ph.D. degree requirements include a minimum of 38 credits of course work and 34 credits of original research. All students are required to prepare and defend an original research proposal. A residence requirement of one academic year must be satisfied, preferably after completion of most of the required course work. For a more detailed account of degree requirements, courses, facilities, faculty research interests, and application procedures, please visit *http://pharmsci.rutgers.edu.*

The two major objectives of the graduate program in pharmaceutical science are (1) to further enhance our current understanding of traditional pharmaceutical sciences, including drug delivery, drug discovery, and drug development; and (2) to rapidly integrate the great strides that have been made in areas like pharmacogenomics, and apply these advances to enhance our understanding of the interrelationships between genomics/molecular genetics and pharmacokinetics/pharmacodynamics.

The graduate program in pharmaceutical science has been designed to provide the necessary didactic courses and research training required for the Ph.D. degree, so that students can excel in this exciting and rapidly changing post-genomic era of the pharmaceutical sciences. The program focuses on multidisciplinary training by bringing together faculty from various departments and programs including pharmaceutics, chemistry, chemical biology, molecular biosciences, and engineering to enhance student training by utilizing the latest technologies at the chemical, cellular, molecular, genomic, biochemical, and clinical levels. This interdisciplinary curriculum has the flexibility to be individualized to meet the interests of each incoming student.

Graduate Courses

16:115:556. ETHICAL SCIENTIFIC CONDUCT (1)

16:663:501. MEDICINAL CHEMISTRY RESEARCH TECHNIQUES AND PRINCIPLES (3)
Kimball, Rice, Weyand
For students preparing to do research in medicinal chemistry. Topics include information management, computer methods, basic laboratory techniques, bioassey techniques, metabolism, pro-drugs, and quantitative structure-activity relationships.

16:663:502. PRINCIPLES OF DRUG DESIGN (3)
Hu, Kerrigan
Principles of drug design. Topics include identifying new drug leads, drug absorption and distribution, pharmacomodulation, enzymes and receptors as targets, peptidomimetics, computer-aided drug design, and combinatorial chemistry.

16:663:504. STRATEGIES AND TACTICS IN SYNTHETIC MEDICINAL CHEMISTRY (3)
Kimball, Rice. Prerequisite: 16:160:503.
Strategies and tactics for the design of syntheses for organic pharmaceutical agents; strategies for the preparation of series of analogs for structure-activity investigations.

16:663:505. DRUGS: STRUCTUREAND FUNCTION (3)
LaVoie, Rice, Weyand. Prerequisites: 01:160:305,306 or equivalent.
Survey of the major pharmaceutical agents in clinical use. Emphasis on the influence of chemical structure in the elicitation of pharmacological effects.

16:720:507. ADVANCED PHARMACEUTICS I (3)
Sinko. Prerequisites: Physical chemistry and associated math requirements.
Application of physical-chemical principles to the study and evaluation of pharmaceutical systems: solubility phenomena, equilibria, complexation, phase transitions, and pharmaceutical stability, and the fundamentals of pharmacokinetics.

16:720:509. ADVANCED PHARMACEUTICS II (3)
Kong. Prerequisites: Ordinary differential equations (or equivalent) and pharmacokinetics.
Kinetics aspects of the pharmaceutical sciences. Quantitative and mechanistic approaches to pharmacokinetics, dissolution rate, and chemical kinetics.

16:720:510. ADVANCED PHARMACOKINETICS (3)
Sinko. Prerequisites: 01:160:327,328.
Kinetics of drug absorption, distribution, and elimination; clearance concepts; compartmental, noncompartmental, and physiological models.

16:720:520. THERAPEUTIC PEPTIDES AND DELIVERY SYSTEMS (3)
Knipp. Prerequisites: 01 or 11:115:301; 30:721:301,302, 403,404, or permission of instructor.
Study of biochemical, biopharmaceutical, and pharmacologic bases of peptide- and protein-based macromolecular drugs, and application of multidisciplinary approaches to their formulation, development, and systemic delivery.

16:720:522. CONTROLLED DRUG DELIVERY RELEASE (3)
Cook. Prerequisites: 16:720:507, 515,516.
Multidisciplinary approaches to concepts, fundamentals, and biomedical assessments in the research and development of novel drug delivery systems.

16:720:540. INDEPENDENT RESEARCH PROPOSAL (3)
Enrollment limited to Ph.D. candidates with approval of their adviser.
Develop a written research proposal using the standard HHS/NIH format as part of the Ph.D. degree requirements. Proposal is evaluated as to its originality, scientific merit, and quality.

16:720:601,602. SEMINAR IN PHARMACEUTICAL SCIENCE (1,1)
Presentation and discussion of recent developments in the pharmaceutical sciences.

16:720:607,608. SPECIAL TOPICS (3,3)
Selected topics in pharmaceutical science.

16:720:609. MOLECULAR AND FUNCTIONAL GENOMIC ASPECTS OF MEMBRANE TRANSPORT (3)
You

16:720:610,611. INDEPENDENT STUDY IN PHARMACEUTICAL SCIENCE (BA,BA)
No more than 3 credits may be taken as part of a student's program.
Independent library and/or laboratory research into special aspects of pharmaceutical science; arranged under the supervision of a specific faculty member.

16:720:612,613. CURRENT TOPICS IN PHARMACEUTICAL SCIENCE (1,1)
Seminar with lectures by scientists from the pharmaceutical industry on advanced topics within a particular area of pharmaceutical science, such as medicinal chemistry, pharmaceutical analysis, and pharmaceutics.

16:720:701,702. RESEARCH IN PHARMACEUTICAL SCIENCE (BA,BA)

16:960:590. DESIGN OF EXPERIMENTS (3)

PHARMACOLOGY, CELLULAR AND MOLECULAR 718

Degree Program Offered: **Doctor of Philosophy**
Director of Graduate Program: **Professor Marc Gartenberg, Department of Pharmacology, University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School (732/235-4757)**

Members of the Graduate Faculty

Debarata Banerjee, *Associate Professor of Medicine and Pharmacology, UMDNJ–RWJMS; Ph.D., Calcutta*
Cancer pharmacology, antifolate research
Joseph Bertino, *Professor of Medicine and Pharmacology, CINJ; M.D., Downstate Medical Center*
Cancer pharmacology, antifolate research
J. Don Chen, *Associate Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Baylor*
Gene regulation by nuclear hormone receptors, leukemia
Peter Cole, *Assistant Professor of Medicine and Pharmacology, UMDNJ–RWJMS; M.D., Cornell*
Cancer pharmacology, antifolate research
Allan H. Conney, *Professor of Pharmacology, EMSP; Ph.D., Wisconsin*
Cytochromes P-450 and drug metabolism; chemical carcinogenesis
Marc R. Gartenberg, *Associate Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Yale*
Nuclear organization of DNA; chromosome structure; yeast plasmid segregation
Herbert M. Geller, *Professor of Pharmacology and Neurology, UMDNJ–RWJMS; Ph.D., Case Western Reserve*
Developmental and cellular neurobiology
William N. Hait, *Professor of Medicine and Pharmacology, UMDNJ–RWJMS; M.D., Ph.D., Medical College of Pennsylvania*
Calcium-calmodulin-mediated signal transduction and drug resistance; cancer pharmacology
Shengkan (Victor) Jin, *Assistant Professor of Pharmacology, CINJ; Ph.D., Cornell*
Tumor suppressor genes, programmed cell death and tumorigenesis
Barton A. Kamen, *Professor of Pediatrics, CINJ; M.D., Ph.D., Case Western Reserve*
Chemotherapy of cancer in children
Frederick C. Kauffman, *Professor of Pharmacology, EMSP; Ph.D., Illinois*
Influence of intermediary metabolism on xenobiotic metabolism; neurotoxicity
Ah-Ng Tony Kong, *Professor of Pharmaceutics, EMSP; Ph.D., SUNY (Buffalo)*
Regulation of gene expression by drugs and xenobiotics; signal transduction and apoptosis
Jeffrey D. Laskin, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., SUNY (Buffalo)*
Carcinogenesis and differentiation in cell culture
John Lenard, *Professor of Physiology, UMDNJ–RWJMS; Ph.D., Cornell*
Enveloped RNAviruses; transcription, replication, entry, and assembly
Fang Liu, *Assistant Professor of Chemical Biology, EMSP; Ph.D., Harvard*
Signal transduction and gene regulation; growth and differentiation control

Leroy F. Liu, *Professor and Chairperson of Pharmacology, UMDNJ–RWJMS; Ph.D., California (Berkeley)*
DNA topoisomerases and control of cell division; cancer pharmacology

Peter Lobel, *Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Columbia*
Molecular mechanisms responsible for targeting lysosome in mammalian cells

Jianjie Ma, *Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., Baylor*
Structure-function studies of ion channels, signal transduction

Randall D. McKinnon, *Assistant Professor of Neurosurgery, UMDNJ–RWJMS; Ph.D., McMaster*
The role of polypeptide growth factors in oligodendrocyte development

Sally A. Meiners, *Assistant Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Michigan State*
Modulation of neuronal growth and regeneration by the extracellular matrix; regeneration in the injured spinal cord

Robert G. Nagele, *Associate Professor of Pediatrics, UMDNJ–SOM; Ph.D., Rutgers*
Structural/functional organization of the cell nucleus

Jerome Parness, *Associate Professor of Anesthesia, Pharmacology, and Pediatrics, UMDNJ–RWJMS; M.D., Ph.D., Yeshiva (Einstein)*
Regulation of intracellular calcium pools

Nicola Partridge, *Professor and Chairperson of Physiology, UMDNJ–RWJMS; Ph.D., Western Australia*
Signal transduction; molecular endocrinology; transcriptional regulation; and metalloproteinases

Daniel S. Pilch, *Assistant Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., California (Berkeley)*
Mechanism of action of topoisomerase poisoning drugs; structure and energetics of specific RNA recognition by drugs and proteins

Larissa A. Pohorecky, *Professor of Neuropharmacology, CAS; Ph.D., Chicago*
Alcohol and psychological stress on brain monoamines and behavior

Eric H. Rubin, *Professor of Medicine and Pharmacology, UMDNJ–RWJMS; M.D., South Florida*
Clinical and molecular approaches to inhibition of DNA topoisomerases

Loren W. Runnels, *Assistant Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., SUNY (Stony Brook)*
Signal transduction, role of the channel-kinase TRPM7 in cell adhesion

Alexey G. Ryazanov, *Associate Professor of Pharmacology, UMDNJ–RWJMS; D.Sci., Moscow State*
Regulation of protein synthesis and the cell cycle

Federico Sesti, *Assistant Professor of Physiology, UMDNJ–RWJMS; Ph.D., Genova*
Physiology, structure, and function and genetic disease of ion channels

Stephen M. Shea, *Professor of Pharmacology, UMDNJ–RWJMS; M.D., National University of Ireland (Galway)*
Transport systems of endothelial surfaces; glomerular filtration

Tetsuo Shimamura, *Professor of Pathology, UMDNJ–RWJMS; M.D., Yokohama*
Structure and function of the renal medulla; urine-concentrating mechanisms

Patricia K. Sonsalla, *Associate Professor of Neurology, Psychiatry, and Pharmacology, UMDNJ–RWJMS; Ph.D., Utah*
Neurotoxicology; monoamines and CNS function

Kevin S. Sweder, *Assistant Professor of Chemical Biology, EMSP; Ph.D., California Institute of Technology*
Repair of DNA damage

Nancy C. Walworth, *Associate Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Yale*
Control of cell cycle progression in yeast

William J. Welsh, *Professor of Pharmacology and Director of the UMDNJ Informatics Institute, UMDNJ–RWJMS; Ph.D., Pennsylvania*
Drug discovery, computer-aided molecular modeling and design, bioinformatics

Donald J. Wolff, *Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Wisconsin*
Pharmacology of nitric oxide synthesis; calcium/calmodulin dependent processes

Chung S. Yang, *Professor of Pharmacognosy, EMSP; Ph.D., Cornell*
Nitrosamines; carcinogenesis; molecular biology of cytochrome P-450 7

Peter D. Yurchenco, *Professor of Pathology and Laboratory Medicine, UMDNJ–RWJMS; M.D., Albert Einstein*
Extracellular matrix

Renping Zhou, *Assistant Professor of Chemical Biology, EMSP; Ph.D., California (Berkeley)*
Molecular mechanisms of neural development

Programs

The study of pharmacology involves several disciplines, using the methods of biochemistry, cell biology, chemistry, molecular biology, and physiology. The graduate program, which is research-oriented, has faculty members from several departments at UMDNJ–Robert Wood Johnson Medical School and Rutgers University. Faculty research covers a range of specialities, including cancer pharmacology, drug design and metabolism, neuropharmacology, and signal transduction. The graduate program also participates in a combined M.D./Ph.D. program.

Applicants who have completed a bachelor's degree in biology, chemistry, or neuroscience are viewed as optimal candidates for admission. However, those with undergraduate training in related areas also are acceptable candidates, provided deficiencies are eliminated during the first year of study.

The Ph.D. program requires a minimum of 72 credits, including 32 credits of course work. At least 24 credits of advanced research must be conducted during one year of residence. Admission to candidacy for the Ph.D. requires the satisfactory completion of course work and a qualifying examination that includes the defense of a detailed research proposal. The doctoral dissertation is based on original laboratory research.

Joint Ph.D. degrees are awarded in this program. See related information at the beginning of this chapter.

In addition to the courses listed below, students draw upon courses offered in other graduate programs, such as biochemistry and molecular biology, computer science, microbiology, neuroscience, physiology, and toxicology. Students are encouraged to participate in seminar programs and journal clubs.

Except for transfer students and M.D./Ph.D. candidates, most students enter the program as recruits from the core curriculum in molecular biosciences. Upon completing the requirements of the core (one year), students opting to specialize in cellular and molecular pharmacology must select a faculty adviser from the program.

Graduate Courses

16:718:565,566. ADVANCED PROBLEMS IN PHARMACOLOGY (BA,BA)
Prerequisites: Permission of graduate director and instructor.
Independent research with a faculty member on some aspect of a research problem. With minimum supervision, students are expected to analyze, interpret, and report the experimental data.

16:718:574. NEUROPHARMACOLOGY (2)
Sonsalla. Prerequisite: Permission of instructor.
Seminar presentations consider the mechanisms of synaptic transmission in the nervous system, role of voltage- and ligand-gated ion channels, and G-protein coupled receptors in information transmission. Material includes the regulation of the synthesis, storage, release, and destruction of neurotransmitters.

16:718:578. DRUG METABOLISM (2)
Conney, Kauffman. Prerequisite: Permission of instructor.
Readings, seminars, and discussions emphasize selected papers from the primary literature pertaining to the metabolism of foreign chemicals. Critical discussions of publications that describe the properties and regulation of foreign compound-metabolizing enzymes in microorganisms, plants, insects, lower mammals, and humans. Consideration of the significance of these enzymes for the metabolism and action of foreign chemicals and endogenous substrates in intact cells and organisms.

16:718:601. GENETICS IN PHARMACOLOGY (2)
Walworth. Prerequisite: Permission of instructor.
Genetic strategies in understanding drug mechanisms and in the search for new pharmaceutically active agents. Some familiarity with genetics advisable.

16:718:602. SEMINAR IN PHARMACOLOGY (1)
Faculty and student presentations.

16:718:603. GENOMICS IN CANCER THERAPEUTICS (3)
Banerjee. Prerequisite: Permission of instructor.
The application of genomics for target discovery using DNA microarrays, target identification for cancer therapeutics based on abnormalities in the cancer cell versus the normal cell and non-invasive imaging of tumors. Gene therapy and differentiation therapy strategies for attacking the tumor cell based on knowledge gained from functional genomics of the tumor cell.

16:718:604. SIGNAL TRANSDUCTION (2)
  Ryazanov. Prerequisite: Permission of instructor.
Biology, pharmacology, and molecular biology of the cell cycle.

16:718:605. DRUG-TARGET INTERACTIONS (2)
  Gartenberg. Prerequisite: Permission of instructor.
Basic principles of the secondary and tertiary structures of nucleic acids used to explore aspects of nucleic acid biology such as protein-nucleic acid interactions, RNA-catalyzed reactions, and nucleic acid pharmacology.

16:718:680. CELLULAR AND MOLECULAR PHARMACOLOGY: PRINCIPLES OF DRUG ACTION AND TARGETING (3)
  Pilch. Prerequisites: Permission of graduate director and instructor.
Molecular basis of pharmacologic selectivity, drug targets, adaptive responses to drugs, disposition of drugs, and genetic and molecular approaches to drug therapy.

16:718:701,702. RESEARCH IN PHARMACOLOGY (BA,BA)

PHARMACY
  (See the catalog of the Ernest Mario School of Pharmacy for information about programs leading to the professional doctor of pharmacy [Pharm.D.] degree. For further information about the Pharm.D. degree, contact Dr. Joseph Barrone at 732/445-3285.)

PHILOSOPHY 730

Degree Programs Offered: **Master of Arts, Doctor of Philosophy**
Director of Graduate Program: **Professor Barry M. Loewer,**
  Davison Hall, Douglass Campus (732/932-9181)

Members of the Graduate Faculty

Frank Arntzenius, *Associate Professor of Philosophy, FAS–NB; Ph.D., London School of Economics*
  Philosophy of science; metaphysics; philosophy of physics
Martha Bolton, *Professor of Philosophy, FAS–NB; Ph.D., Michigan*
  Early modern philosophy
Robert H. Bolton, *Professor of Philosophy, FAS–NB; Ph.D., Michigan*
  Ancient philosophy; philosophy of language; metaphysics
Martin R. Bunzl, *Professor of Philosophy, FAS–NB; Ph.D., Minnesota*
  Philosophy of science
Ruth Chang, *Assistant Professor of Philosophy, FAS–NB/SL–C; J.D., Harvard; D.Phil., Oxford*
  Philosophy of law; ethics
Frances Egan, *Associate Professor of Philosophy, FAS–NB; Ph.D., Western Ontario*
  Philosophy of psychology; philosophy of mind; philosophy of science
Jerry A. Fodor, *Professor of Philosophy, FAS–NB; Ph.D., Princeton*
  Philosophy of mind; cognitive psychology
Alvin Goldman, *Professor of Philosophy, FAS–NB; Ph.D., Princeton*
  Epistemology; metaphysics; philosophy of mind; cognitive science; evidence and law
John Hawthorne, *Professor of Philosophy, FAS–NB; Ph.D., Syracuse*
  Metaphysics; epistemology; language; mind; Leibniz
Douglas N. Husak, *Professor of Philosophy, FAS–NB; Ph.D., J.D., Ohio State*
  Philosophy of law; social and political philosophy; ethics
Peter Kivy, *Professor of Philosophy, FAS–NB; Ph.D., Columbia*
  Aesthetics; early modern philosophy
Peter D. Klein, *Professor of Philosophy, FAS–NB; Ph.D., Yale*
  Epistemology
Ernest P. Lepore, *Professor of Philosophy, FAS–NB; Ph.D., Minnesota*
  Philosophy of language
Brian Loar, *Professor of Philosophy, FAS–NB; D.Phil., Oxford*
  Philosophy of mind; philosophy of language; metaphysics
Barry M. Loewer, *Professor of Philosophy, FAS–NB; Ph.D., Stanford*
  Philosophy of science; logic; philosophy of mind
Robert Matthews, *Professor of Philosophy, FAS–NB; Ph.D., Cornell*
  Philosophy of psychology and language; theoretical psycholinguistics

Tim Maudlin, *Professor of Philosophy, FAS–NB; Ph.D., Pittsburgh*
  Philosophy of science; ancient philosophy; epistemology
Howard McGary, Jr., *Professor of Philosophy, FAS–NB; Ph.D., Minnesota*
  Social and political philosophy; ethics; Afro-American philosophy
Colin McGinn, *Professor of Philosophy, FAS–NB; B.Phil., Oxford*
  Philosophy of mind; metaphysics; Wittgenstein
Brian P. McLaughlin, *Chairperson and Professor of Philosophy, FAS–NB; Ph.D., North Carolina*
  Metaphysics; epistemology; philosophy of mind
Jefferson McMahan, *Professor of Philosophy, FAS–NB; Ph.D., Cambridge*
  Ethics, personal identity
Stephen Neale, *Professor of Philosophy, FAS–NB; Ph.D., Stanford*
  Logic; philosophy of language
Theodore Sider, *Associate Professor of Philosophy, FAS–NB; Ph.D., Massachusetts (Amherst)*
  Metaphysics; philosophy of language
Holly Smith, *Professor of Philosophy, Executive Dean of the Faculty of Arts and Sciences and Dean of the Graduate School–New Brunswick; Ph.D., Michigan*
  Normative ethics; metaethics; biomedical ethics
Ernest Sosa, *Professor of Philosophy, Brown University, and Professor of Philosophy, FAS–NB; Ph.D., Pittsburgh*
  Epistemology; metaphysics
Stephen P. Stich, *Professor of Philosophy, FAS–NB; Ph.D., Princeton*
  Epistemology; philosophy of psychology
Larry Temkin, *Professor of Philosophy, FAS–NB; Ph.D., Princeton*
  Normative ethics, metaethics, social and political philosophy
Simon Thomas, *Professor of Mathematics, FAS–NB; Ph.D., London*
  Model theory; infinite groups
Bruce Wilshire, *Professor of Philosophy, FAS–NB; Ph.D., New York*
  Aesthetics; American philosophy; phenomenology and existentialism
Dean Zimmerman, *Associate Professor of Philosophy, FAS–NB; Ph.D., Brown*
  Metaphysics; philosophy of religion

Associate Members of the Graduate Faculty

Mark Baker, *Professor of Linguistics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
  Syntax; syntax-semantics interface
Dennis Patterson, *Distinguished Professor of Law and Philosophy, SL–C; Ph.D., SUNY (Buffalo)*
  Philosophy of law; language; Wittgenstein
Pierre Pellegrin, *Visiting Professor of Philosophy, FAS–NB; Professor of Philosophy, CREA(France); Ph.D., Paris I*
  Ancient philosophy
Kenneth J. Safir, *Professor of Linguistics, FAS–NB; Ph.D., Massachusetts Institute of Technology*
  Learnability theory
Kirk Sanders, *Assistant Professor of Classics, FAS–NB; Ph.D., Texas*
  Ancient philosophy
Andrew von Hirsch, *Professor of Criminal Justice, SCJ; LL.B., Harvard*
  Philosophy of criminal law; criminal sentencing theory and policy
Robert L. Woolfolk, *Professor of Psychology, FAS–NB; Ph.D., Texas (Austin)*
  Behavioral therapy

Programs

The faculty in philosophy offers a comprehensive program of doctoral studies covering the principal branches of the subject. The program is organized to give students breadth of background before they specialize. The curriculum, which provides a wide range of options in the later stages of study, is complemented by related advanced-study courses in other disciplines at the Graduate School–New Brunswick. The program leading to the Ph.D. requires 48 credits, or 16 courses, taken at the rate of four courses a term. Teaching assistants take only three courses a term. In addition, the program requires 24 credits of research. There is no residency requirement.

Applicants with distinguished undergraduate records who lack certain prerequisites for graduate study in philosophy may be accepted if they remedy these deficiencies by taking undergraduate courses without graduate credit.

There are five requirements in the doctoral program in philosophy. The first, the course requirement, specifies that the student must pass 16 courses (worth 48 credits) that have been approved by the department. The second, the distribution requirement, ensures that students have a broad background in philosophy. To meet this standard, students must earn a grade of *B* or better in one designated 500-level course in each of six areas of the subject. In addition, they must earn a *B* or better in another two 500- or 600-level courses taken in four of the six specialty areas. These areas of distribution are

1. ancient/medieval philosophy (up to 1600 A.D.)
2. modern philosophy
3. logic and philosophy of language
4. epistemology and philosophy of science
5. metaphysics and philosophy of mind
6. ethics and value theory

Successful completion of the next two requirements constitutes passing the qualifying examination. These two requirements are the literature review and the area-of-concentration requirement, which measures a student's specialized knowledge. To complete the area-of-concentration requirement, students must pass a comprehensive examination in one of the six specialty areas listed above.

As soon as possible after passing the area examination, the student chooses a predissertation adviser and then meets with the graduate director to begin satisfying the predissertation requirements. The graduate director, in consultation with the student, appoints a predissertation committee of three members of the graduate faculty, including the adviser. The predissertation requirements are a predissertation paper ("proto-chapter"), a dissertation proposal, and a predissertation oral examination.

By successfully completing the predissertation requirements, the student qualifies to advance to the candidacy stage.

After a student has met the first four requirements, the final requirement is the dissertation. To be accepted, the dissertation must be judged publishable as measured by style, scholarship, and originality.

When a student has reached the dissertation stage, the director of the graduate program, in consultation with the student, appoints a dissertation committee, with one member designated as dissertation adviser, to direct the student's work on the dissertation. This committee must approve formally the dissertation proposal, and all members of the committee must approve the completed dissertation.

To obtain a master of arts degree, a student must (1) satisfy all of the master's degree area-distribution course requirements (including nine courses in philosophy); (2) pass with grades of B or better 30 credits of courses approved by the philosophy department; and (3) pass the area-of-concentration requirement. The latter requirement constitutes the comprehensive examination.

Normally, the master of arts in philosophy is not offered as a terminal degree and is taken only by students enrolled in the Ph.D. program.

Graduate Courses

16:730:501. SURVEY IN EPISTEMOLOGY AND METAPHYSICS (3)
A survey of central work in epistemology and metaphysics. Topics include modality, causation, laws, personal identity, freedom, skepticism, internalism and externalism, foundationalism.

16:730:502. SURVEY IN PHILOSOPHY OF MIND AND LANGUAGE (3)
A survey of central work in philosophy of mind and language. Topics include theories of reference, theories of meaning, physicalism, functionalism, intentionality, language of thought, consciousness, and qualia.

16:730:503. SURVEY IN VALUE THEORY (3)
A survey of central work in ethics, social and political philosophy. Topics include virtue theory, Kant, utilitarianism, consequentialism, nonnaturalism, emotivism, antirealism, justice as fairness, rights, liberalism.

16:730:504. SURVEY IN PHILOSOPHY OF SCIENCE AND DECISION THEORY (3)
A survey of central work in philosophy of science and decision theory. Topics include confirmation theory, scientific explanation, scientific realism, Bayesian decision theory, representation theorems, game theory.

16:730:510. (F) MATHEMATICAL LOGIC (3)
Introduction to the basic results of mathematical logic, including completeness, indecidability, and Godel's theorems.

16:730:513. (F) LOGIC AND NATURAL LANGUAGE (3)
Prerequisite: 16:730:510.
Logic as a tool in the semantic analysis of natural language; relation between symbolic and natural languages.

16:730:520. SEMINAR IN PLATO (3)
Study of representative works from the main periods of Plato's thought.

16:730:521. SEMINAR IN ARISTOTLE (3)
Study of some main works of central importance in the Aristotelian Corpus.

16:730:526. SEMINAR IN MEDIEVAL PHILOSOPHY (3)
Medieval metaphysics; philosophy of nature and epistemology; time and eternity; the infinite; creation; causality; skepticism.

16:730:530. SEMINAR IN 17TH-CENTURY PHILOSOPHY (3)
Examination of a major philosopher, work, or topic of the period. Emphasis on metaphysics and epistemology; connections with other problems in philosophy and the natural sciences.

16:730:533. SEMINAR IN 18TH-CENTURY PHILOSOPHY (3)
Examination of a major philosopher, work, or topic of the period. Emphasis on metaphysics and epistemology; connections with other problems in philosophy and the natural sciences.

16:730:536. SEMINAR IN 19TH-CENTURY PHILOSOPHY (3)
From post-Kantian idealism to the early stages of phenomenology.

16:730:550. SEMINAR IN EPISTEMOLOGY (3)
Nature of justification, belief, and truth; rival accounts of knowledge; traditional and contemporary perspectives on empiricism, rationalism and pragmaticism, and skepticism.

16:730:553. SEMINAR IN METAPHYSICS (3)
The problem of universals. Concepts of the infinite, time, causality, notions of possibility and necessity, and counterfactuals.

16:730:556. SEMINAR IN PHILOSOPHY OF SCIENCE (3)
Philosophical problems connected with modern science.

16:730:570. SEMINAR IN PHILOSOPHY OF LANGUAGE (3)
The nature and varieties of linguistic meaning; signs and symbols; speech acts criteria of meaningfulness.

16:730:575. SEMINAR IN PHILOSOPHY OF MIND (3)
Contemporary discussions of cognitive and noncognitive mental activities and their influences on behavior; analyses of self-knowledge and self-deception; theories of mind-body identity.

16:730:580. SEMINAR IN ETHICS (3)
Typically concerned with several philosophers (e.g., Aristotle, Hume, Kant, Mill) or problems, such as rights, justice, virtue, relativism, nihilism, utilitarianism.

16:730:583. SEMINAR IN SOCIAL AND POLITICAL PHILOSOPHY (3)
Some recent philosophical theories and their relevance to contemporary issues in social science and politics.

16:730:585. SEMINAR IN PHILOSOPHY OF LAW (3)
The concept of law and criteria of legal validity. Relation of these issues to questions of political obligation and the limits of judicial discretion.

16:730:590. SEMINAR IN AESTHETICS (3)
Study of representation, interpretation, and evaluation. The definition and the ontology of art. Expressive properties, artistic qualities, metaphorical expressions.

16:730:595. SEMINAR ON TEACHING (N3)
Techniques and problems of teaching philosophy to undergraduates.

16:730:601,602. SPECIAL STUDIES IN PHILOSOPHY (BA,BA)

16:730:620. ADVANCED TOPICS IN PLATO (3)
Intensive study of selected dialogues or topics in Plato's philosophy.

16:730:621. ADVANCED TOPICS IN ARISTOTLE (3)
Intensive study of selected works or topics in Aristotle's philosophy.

16:730:624. ADVANCED TOPICS IN ANCIENT PHILOSOPHY (3)
Detailed examination of selected central issues or writers, such as Parmenides and the early pluralists, theories of language, early Stoics, ancient Scepticism.

16:730:626. ADVANCED TOPICS IN MEDIEVAL PHILOSOPHY (3)
Detailed examination of selected central topics in metaphysics, philosophy of nature, and epistemology. Readings in translations from original sources.

16:730:630. ADVANCED TOPICS IN 17TH-CENTURY PHILOSOPHY (3)
Detailed examination of a problem, such as Descartes' theory of method, Spinoza's doctrine of substance and attributes, or controversies about the nature of time and space.

16:730:633. ADVANCED TOPICS IN 18TH-CENTURY PHILOSOPHY (3)
Detailed examination of a problem (e.g., Berkeley's and Hume's attack on abstract ideas, Kant's refutation of idealism, issues in the theory of perception).

16:730:636. ADVANCED TOPICS IN 19TH-CENTURY PHILOSOPHY (3)
Post-Kantian philosophy from Fichte to Nietzsche. The new social sciences; theories of interpretation; anticipations of 20th-century philosophy.

16:730:640. ADVANCED TOPICS IN AMERICAN PHILOSOPHY (3)
Reception and transformation of European world views by American philosophers from Peirce to Dewey. Emphasis on notions of meaning, truth, freedom, and education.

16:730:645. ADVANCED TOPICS IN CONTINENTAL PHILOSOPHY (3)
Husserl's different conceptions of philosophy. Existential phenomenology: Heidegger and Merleau-Ponty. Contemporary Marxism. The tension between analytic and continental thought.

16:730:648. ADVANCED TOPICS IN ANALYTIC PHILOSOPHY (3)
Writings of such authors as Russell, Moore, Carnap, Wittgenstein, Ryle, and Strawson.

16:730:650. ADVANCED TOPICS IN EPISTEMOLOGY (3)
Detailed examination of selected central issues or writers, such as scepticism, causal theories of perception and knowledge, epistemic rationality, Wittgenstein's *On Certainty.*

16:730:653. ADVANCED TOPICS IN METAPHYSICS (3)
Intensive examination of one or two selected issues in contemporary metaphysics.

16:730:656. ADVANCED TOPICS IN PHILOSOPHY OF SCIENCE (3)
Intensive examination of one or two selected issues in contemporary philosophy of science.

16:730:658. ADVANCED TOPICS IN PHILOSOPHY OF PHYSICS (3)
Philosophical issues related to particular areas of both classical and modern physics. Discussions of relativity and quantum theory.

16:730:660. ETHICS AND LITERATURE (3)
Examination of ethical issues as they arise within literary texts, focusing on the nature of evil, questions of character and motivation, and the way such matters are treated by literary works.

16:730:664. ADVANCED TOPICS IN PHILOSOPHY OF SOCIAL SCIENCE (3)
Intensive examination of one or two selected issues in contemporary philosophy of social science.

16:730:667. ADVANCED TOPICS IN PHILOSOPHY OF HISTORY (3)
Conceptions of historical knowledge from the early 19th century to the present; explanation and understanding; narration and description in historical writings; limits of historical understanding.

16:730:670. ADVANCED TOPICS IN PHILOSOPHY OF LANGUAGE (3)
Intensive examination of one or two selected issues in contemporary philosophy of language.

16:730:675. ADVANCED TOPICS IN PHILOSOPHY OF MIND (3)
Intensive examination of one or two selected issues in contemporary philosophy of mind.

16:730:676. ADVANCED TOPICS IN THE PHILOSOPHY OF PSYCHOLOGY (3)
Examination of selected topics in the philosophy of psychology, focusing especially on issues in the foundations of cognitive/computational psychology. Topics include representationalism, learnability theory, the innateness controversy.

16:730:678. ADVANCED TOPICS IN DECISION THEORY (3)
The logic of choice and of action; valuation and probability; risk and uncertainty; coherence and rationality. Survey of current theories and of outstanding problems.

16:730:679. TOPICS IN LOGIC (3)
Survey of a variety of topics in logic.

16:730:680. ADVANCED TOPICS IN ETHICS (3)
Intensive examination of one or two selected issues in contemporary ethics.

16:730:683. ADVANCED TOPICS IN SOCIAL AND POLITICAL PHILOSOPHY (3)
Intensive examination of one or two selected issues in contemporary social and political philosophy.

16:730:685. ADVANCED TOPICS IN PHILOSOPHY OF LAW (3)
Limits of state authority in the context of criminal law. Conduct beyond criminal sanction. Discussions of paternalism, obscenity, negligence, strict liability, mistake, excuses, justifications, harm.

16:730:690. ADVANCED TOPICS IN AESTHETICS (3)
Study of representation, interpretation, and evaluation. The definition and ontology of art. Expressive properties, artistic qualities, metaphorical expressions.

16:730:692. ADVANCED TOPICS IN INTERPRETING: THEORY AND PRACTICE (3)
Development of our notions of interpretation since the late 18th century. The search for a theory supporting interpretive decisions. Sceptical challenges raised against such theories.

16:730:693. ADVANCED TOPICS IN PHILOSOPHY OF RELIGION (3)
Detailed examination of a problem in the contemporary literature, such as divine omniscience, religion and morality, problem of evil, the nature of religious belief.

16:730:695. PROSEMINAR IN PHILOSOPHY (3)
Open only to upper-level Ph.D. students in philosophy.
Advanced seminar in which students present their dissertation research.

16:730:701,702. RESEARCH IN PHILOSOPHY (BA,BA)

PHYSICS AND ASTRONOMY 750

Degree Programs Offered: **Master of Science, Master of Science for Teachers, Master of Philosophy, Doctor of Philosophy**
Director of Graduate Program: **Professor Theodore B. Williams, Serin Physics Laboratories, Busch Campus (732/445-2502)**
Email: *graduate@physics.rutgers.edu*
Web Site: *http://www.physics.rutgers.edu*

Members of the Graduate Faculty

Elihu Abrahams, *Bernard Serin Professor of Physics and Astronomy, FAS–NB; Ph.D., California (Berkeley)*
Theoretical condensed-matter physics

Eva Y. Andrei, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Rutgers*
Experimental condensed-matter physics

Natan Andrei, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Princeton*
Theoretical condensed-matter and particle physics

Thomas Banks, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Theoretical elementary particle physics

Robert A. Bartynski, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Pennsylvania*
Experimental condensed-matter physics

John B. Bronzan, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Princeton*
Theoretical elementary particle physics

Kieron Burke, *Associate Professor of Chemistry, FAS–C; Ph.D., California (Santa Barbara)*
Theoretical condensed matter, surface, and chemical physics

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Experimental condensed-matter physics

Yves Chabal, *Professor of Biomedical Engineering and Chemistry, SE/FAS–NB; Ph.D., Cornell*
Interface physics of electronic, photonic, and biomaterials

Premala Chandra, *Professor of Physics and Astronomy, FAS–NB; Ph.D., California (Santa Barbara)*
Condensed matter theory

Sang-Wook Cheong, *Professor of Physics and Astronomy, FAS–NB; Ph.D., California (Los Angeles)*
Experimental condensed-matter physics and material science

Jolie A. Cizewski, *Professor of Physics and Astronomy, FAS–NB; Ph.D., SUNY (Stony Brook)*
Experimental nuclear physics

Piers Coleman, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Princeton*
Theoretical condensed-matter physics

John Conway, *Associate Professor of Physics and Astronomy, FAS–NB; Ph.D., Chicago*
Experimental elementary particle physics

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Observational astronomy and astrophysics

Mark C. Croft, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Rochester*
Experimental condensed-matter physics

Thomas J. Devlin, *Professor of Physics and Astronomy, FAS–NB; Ph.D., California (Berkeley)*
Experimental elementary particle physics

Duiliu-Emanuel Diaconescu, *Assistant Professor of Physics and Astronomy, FAS–NB; Ph.D., Rutgers*
Theoretical high-energy physics

Michael R. Douglas, *Professor of Physics and Astronomy, FAS–NB; Ph.D., California Institute of Technology*
Theoretical elementary particle physics

Eugenia Etkina, *Assistant Professor of Education, GSE; Ph.D., Moscow State Pedagogical*
Physics education

Laura Ferrarese, *Research Assistant Professor of Physics and Astronomy, FAS–NB; Ph.D., Johns Hopkins*
Observational astronomy and astrophysics

Daniel Friedan, *Professor of Physics and Astronomy, FAS–NB; Ph.D., California (Berkeley)*
Theoretical elementary particle physics

Eric Garfunkel, *Professor of Chemistry, FAS–NB; Ph.D., California (Berkeley)*
Experimental surface science

Michael E. Gershenson, *Associate Professor of Physics and Astronomy, FAS–NB; Ph.D., Institute of Radio Engineering and Electronics (Moscow)*
Experimental condensed-matter physics

Ronald Gilman, *Associate Professor of Physics and Astronomy, FAS–NB; Ph.D., Pennsylvania*
Experimental nuclear physics

Charles M. Glashausser, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Princeton*
Experimental nuclear physics

Sheldon Goldstein, *Professor of Mathematics, FAS–NB; Ph.D., Yeshiva*
Foundations of quantum mechanics, mathematical physics

Torgny Gustafsson, *Professor of Physics and Astronomy, FAS–NB; D.Sc., Chalmers (Sweden)*
Experimental condensed-matter physics

David R. Harrington, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Carnegie Institute of Technology*
Theoretical nuclear physics

B. Jane Hinch, *Associate Professor of Chemistry, FAS–NB; Ph.D., Cambridge*
Surface studies using atomic and molecular scattering

George K. Horton, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Birmingham*
Theoretical condensed-matter physics

John Hughes, *Associate Professor of Physics and Astronomy, FAS–NB; Ph.D., Columbia*
Observational astrophysics

Lev Ioffe, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Landau Institute for Theoretical Physics*
Condensed-matter theory

Charles L. Joseph, *Assistant Research Professor of Physics and Astronomy, FAS–NB; Ph.D., Colorado*
Observational astronomy and detector development

Mohan S. Kalelkar, *Associate Chairperson and Professor of Physics and Astronomy, FAS–NB; Ph.D., Columbia*
Experimental elementary particle physics

Valery Kiryukhin, *Assistant Professor of Physics and Astronomy, FAS–NB; Ph.D., Princeton*
Experimental condensed-matter physics

Willem M. Kloet, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Utrecht*
Theoretical nuclear physics

Haruo Kojima, *Professor of Physics and Astronomy, FAS–NB; Ph.D., California (Los Angeles)*
Experimental condensed-matter physics

Noémie Koller, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Columbia*
Experimental nuclear physics

Arthur Kosowsky, *Assistant Professor of Physics and Astronomy, FAS–NB; Ph.D., Chicago*
Theoretical astrophysics

B. Gabriel Kotliar, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Princeton*
Theoretical condensed-matter physics

David C. Langreth, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Illinois*
Theoretical condensed-matter physics

Amitabh Lath, *Assistant Professor of Physics and Astronomy, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Experimental high-energy physics

Paul L. Leath, *Chairperson and Professor of Physics and Astronomy, FAS–NB; Ph.D., Missouri*
Theoretical condensed-matter physics

Joel L. Lebowitz, *George William Hill Professor Emeritus of Mathematics and Physics and Astronomy, FAS–NB; Ph.D., Syracuse*
Mathematical physics and statistical mechanics

Ronald Levy, *Professor of Chemistry, FAS–NB; Ph.D., Harvard*
Biophysical chemistry, chemical physics, dynamics of macromolecules

Peter Lindenfeld, *Professor Emeritus of Physics and Astronomy, FAS–NB; Ph.D., Columbia*
Experimental condensed-matter physics

Claud W. Lovelace, *Professor of Physics and Astronomy, FAS–NB; B.S., Capetown*
Theoretical elementary particle physics

Sergei Lukyanov, *Assistant Professor of Physics and Astronomy, FAS–NB; Ph.D., Landau Institute for Theoretical Physics (Moscow)*
Quantum field theory and statistical mechanics

Theodore E. Madey, *State of New Jersey Professor of Surface Science and Director of the Laboratory for Surface Modification, FAS–NB; Ph.D., Notre Dame*
Experimental surface science physics

Terry A. Matilsky, *Associate Professor of Physics and Astronomy, FAS–NB; Ph.D., Princeton*
Observational astrophysics

Aram Z. Mekjian, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Maryland*
Theoretical nuclear physics

David R. Merritt, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Princeton*
Theoretical astrophysics

Gregory Moore, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Harvard*
Theoretical high-energy physics

Daniel E. Murnick, *Professor of Physics, FAS–N; Ph.D., Massachusetts Institute of Technology*
Experimental nuclear and atomic physics

Herbert Neuberger, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Tel Aviv*
Theoretical elementary particle physics

Wilma K. Olson, *Mary I. Bunting Professor of Chemistry, FAS–NB; Ph.D., Stanford*
Theoretical studies of nucleic acid structure and properties

Richard J. Plano, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Chicago*
Experimental elementary particle physics

Carlton P. Pryor, *Associate Professor of Physics and Astronomy, FAS–NB; Ph.D., Harvard*
Observational astrophysics

Karin Rabe, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Theoretical condensed-matter and surface physics

Ronald D. Ransome, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Texas (Austin)*
Experimental nuclear physics

Andrei E. Ruckenstein, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Cornell*
Theoretical condensed-matter physics

Joseph V. Sak, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Institute of Solid State Physics (Prague)*
Theoretical condensed-matter physics

Stephen R. Schnetzer, *Professor of Physics and Astronomy, FAS–NB; Ph.D., California (Berkeley)*
Experimental elementary particle physics

Jeremy Sellwood, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Manchester*
Theoretical astrophysics

Anirvan M. Sengupta, *Associate Professor of Physics and Astronomy, FAS–NB; Ph.D., Bombay*
Biological physics

Joel A. Shapiro, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Cornell*
Theoretical elementary particle physics

Earl D. Shaw, *Professor of Physics, FAS–N; Ph.D., California (Berkeley)*
Experimental laser physics

Boris I. Shraiman, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Harvard*
Theoretical physics research

Sunil Somalwar, *Associate Professor of Physics and Astronomy, FAS–NB; Ph.D., Chicago*
Experimental particle physics

Gordon Thomson, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Harvard*
Experimental elementary particle physics

David Vanderbilt, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Theoretical condensed-matter physics

Alan Van Heuvelen, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Colorado*
Physics education

Russell E. Walstedt, *Distinguished Visiting Scientist in Physics and Astronomy, FAS–NB; Ph.D., California (Berkeley)*
Experimental condensed-matter physics

Terence L. Watts, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Yale*
Experimental elementary particle physics

Theodore Williams, *Associate Chairperson and Professor of Physics and Astronomy, FAS–NB; Ph.D., California Institute of Technology*
Observational astrophysics

Steve Worm, *Assistant Professor of Physics and Astronomy, FAS–NB; Ph.D., Texas*
Experimental high energy physics

Larry Zamick, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Massachusetts Institute of Technology*
Theoretical nuclear physics

Alexander Zamolodchikov, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Institute of Theoretical and Experimental Physics (Moscow)*
Theoretical elementary particle physics

Harold S. Zapolsky, *Professor of Physics and Astronomy, FAS–NB; Ph.D., Cornell*
Theoretical astrophysics

Frank M. Zimmermann, *Associate Professor of Physics and Astronomy, FAS–NB; Ph.D., Cornell*
Experimental surface-science physics

Associate Members of the Graduate Faculty

Gerald Goldin, *University Director, Science and Mathematics Partnerships, and Professor of Mathematics and Physics Education, GSE; Ph.D., Princeton*
Mathematical physics; secondary education

George H. Sigel, Jr., *Professor of Ceramics, and Director, Fiber Optics Materials Research Program, SE; Ph.D., Georgetown*
Optic materials; infrared transmitting materials; radiation-resistant materials

Programs

The research activities of the program are both theoretical and experimental and cover the main areas of interest in contemporary physics, including astrophysics, condensed-matter and statistical physics, surface physics, elementary particle physics, and nuclear physics. Experimental facilities are located on campus in Serin, a modern research laboratory. The surface modification and interface dynamics laboratory houses 1.7 MeV tandetron and 400-keV ion accelerators as well as scanning tunneling microscopes and other surface analytical equipment. There also are several mK-range dilution refrigerators available that are used in low-temperature physics studies. Nuclear structure experiments are carried out at accelerators at Yale University and the Argonne; Oak Ridge, Tennessee; and Lawrence Berkeley National

Laboratories in Berkeley, California. Intermediate experiments are done at the continuous electron beam facilities at Mainz, Germany, and at the Thomas Jefferson National Accelerator Facility in Newport News, Virginia. Elementary-particle physics experiments are carried out at the Fermi National Accelerator Laboratory in Batavia, Illinois, and at the Stanford Linear Accelerator Center in Menlo Park, California. Rutgers astrophysicists use the Kitt Peak Observatory in Arizona and the Cerro-Tololo facilities in Chile. The Rutgers faculty also is involved in a consortium that is constructing the SALT telescope in South Africa.

The program for the master's degree requires a minimum of 30 credits and includes either a critical essay or a thesis on a research problem.

The program for the Ph.D. degree requires a dissertation and an appropriate combination of course work and research credits. The qualifying examination is given in two parts, written and oral. With the approval of the graduate director, courses in other programs may be added to those conducted by the graduate program in physics and astronomy. Ph.D. candidates normally are expected to spend at least one year in full-time residence, although this requirement may be waived by the graduate studies committee. There is no language requirement. The master of philosophy degree is available to doctoral candidates.

Teaching assistantships or research fellowships are available for both first-year and advanced graduate students, and virtually all students receive financial support. Assistants spend no more than 15 hours per week on their duties and normally take 6 to 10 credits of graduate courses each term. Fellowships normally do not entail special duties, and those who hold fellowships can devote their entire time to course work and to research for their Ph.D. dissertation.

Applications should include the results of the general aptitude test and the advanced physics test of the Graduate Record Examination. Applicants whose native language is not English are required to take the TOEFLor the IELTS examinations. Further information about these and other matters may be found in the *Graduate Program in Physics,* a brochure available from the program director or at the program's web site.

Graduate Courses

16:750:501,502. QUANTUM MECHANICS (3,3)
Coleman. Prerequisite: 01:750:417 or equivalent.
Historical introduction; waves and wave packets; one-dimensional problems; representation theory; angular momentum and spin; time-dependent and time-independent perturbation theory, the WKB approximation; atomic and molecular systems; theory of scattering; semiclassical theory of radiation; Dirac equation.

16:750:503. (F) ELECTRICITY AND MAGNETISM I (3)
Sak. Prerequisite: 01:750:386 or equivalent.
Advanced electromagnetic theory and related mathematical techniques. Boundary-value problems in electrostatics and magnetostatics. Complex variables. Green's functions, multipole expansions. Maxwell's equations and plane electromagnetic waves; waveguides.

16:750:504. (S) ELECTRICITY AND MAGNETISM II (3)
Sak. Prerequisite: 16:750:503.
Radiation. Detailed discussion of special relativity, including space-time diagrams, covariance and invariance, twin paradox, uniform acceleration, motion of a charged particle, stress-energy tensors. Radiation by moving charges, bremsstrahlung, multipole fields, radiation damping.

16:750:505. (S) QUANTUM ELECTRONICS (3)
Prerequisite: 01:750:417 or equivalent.
Modern optics; atomic and solid-state phenomena; masers, lasers, theory of amplification, oscillation, coherence; photon correlations; nonlinear optics. Electron and nuclear magnetic resonance. Tunneling phenomena.

16:750:506. (S) MODERN EXPERIMENTAL TECHNIQUES (4)
Prerequisites: 01:750:326, 388, or equivalent.
Modern instruments and techniques in experimental physics. Topics include passive network theory and transient and steady-state response analysis; transmission lines; operational amplifiers; digital circuits; a detailed study of noise; phase sensitive detection, including lock-in amplifiers and signal averagers; low-level measurement techniques, including quantum interference devices; particle detection techniques.

16:750:507. (F) CLASSICAL MECHANICS (3)
Lukyanov. Prerequisite: 01:750:382 or equivalent.
Advanced classical mechanics: Lagrangian mechanics, calculus of variations. Hamilton's equations, canonical transformations, Hamilton-Jacobi theory, small oscillations. Rigid body motion.

16:750:509. (S) PHYSICS APPLICATION OF COMPUTERS (3)
Kotliar. Lec. 2 hrs., lab. 3 hrs. Prerequisite: Programming experience.
Survey of applications. Survey of hardware and software of a computer installation; interactive computing. Advanced Fortran, program structures, style, documentation, debugging. Machine language basics, data acquisition, equipment control. Use of data tapes, data processing. Monte Carlo techniques. Statistics and data fitting. Basic numerical methods. Laboratory: programming on several computers. Broadens knowledge of applications and facilitates development of techniques.

16:750:511. (F) MATHEMATICAL PHYSICS (3)
Zapolsky. Prerequisites: 01:640:403, 423, or equivalent.
Physical applications of linear algebra, the exterior calculus, differential forms, complexes, and cohomology. Applications include Hamiltonian dynamics, normal-mode analysis, Markov processes, thermodynamics, Schröedinger's equation, special relativity, electrostatics, magnetostatics, Maxwell's equations, and wave equations.

16:750:523. (F) TECHNIQUES IN EXPERIMENTAL PHYSICS (3)
Prerequisite: Elementary physics laboratory. Not intended for students in the Ph.D. program.
Electronics as it is used in experimental physics. Transistors and their equivalent circuits, amplifiers, networks, digital logic, light and particle detectors, low-level measurements, including quantum interference devices.

16:750:524. (S) TOPICS IN PHYSICS (3)
Not intended for students in the Ph.D. program.
Self-paced course in which the student studies independently and the faculty act as tutors, providing help as needed and administering examinations. Subject matter divided into units, covering a wide range of subjects drawn from classical and modern physics. Units chosen in consultation with an adviser, taking into account the background and interests of each student.

16:750:541. STARS AND STAR FORMATION (3)
Observed properties of stars. The internal structure of stars, energy generation and transport, neutrinos, solar oscillations. The evolution of isolated and double stars, red giants, white dwarfs, variable stars, supernovae. Challenges presented by the formation of stars, the importance of magnetic fields. Pre-main sequence stellar evolution.

16:750:543. GALAXIES AND THE MILKY WAY (3)
Properties of galaxies; photometry, kinematics, and masses. Disk galaxies; spiral patterns, bars and warps, gas content, star formation rates, chemical evolution. Elliptical galaxies: shapes. Structure of the Milky Way. The nature of dark matter.

16:750:601,602. (F) SOLID-STATE PHYSICS (3,3)
N. Andrei. Prerequisites: 01:750:351 and 16:750:502, or equivalent.
Introduction to crystal lattices, scattering of radiation, lattice dynamics, electron bands, interaction among elementary excitations, disordered systems, transport properties, superconductivity and superfluidity, magnetism, crystal-field effects, phase transitions, optical properties.

16:750:603. (S) SOLID-STATE PHYSICS (3)
Prerequisite: 16:750:601 or equivalent.
Advanced treatment of the areas surveyed in 16:750:601 and their extension to topics of current interest in solid-state physics.

16:750:605. (S) NUCLEAR PHYSICS (3)
Kloet. Prerequisite: 16:750:502 or equivalent.
Survey of essential topics: properties of ground states, shell model, collective model, electromagnetic properties, sample excitations, compound-nucleus and direct reactions, beta decay. Additional topics may include alpha decay, fission, applications of nuclear physics, topics of current interest.

16:750:606. (S) NUCLEAR PHYSICS (3)
Advanced treatment of some topics discussed in 16:750:605, together with additional topics chosen in consultation with students.

16:750:607. (F) GALACTIC DYNAMICS (3)
Merritt. Prerequisites: 01:750:341-342, 16:750:507, or equivalents.
Equilibrium and stability of stellar systems and the dynamical evolution of galaxies. Modern approach to dynamics with a few practical examples of chaotic systems.

16:750:608. (F) COSMOLOGY (3)
Kosowsky. Prerequisites: 01:750:341-342 or equivalent.
Models of the universe, their fundamental parameters, and their estimation from observations. Evolution of the universe from soon after its formation to the present. Growth of structure and the formation of galaxies.

16:750:609. (F) FLUID AND PLASMA PHYSICS (3)
Prerequisite: 16:750:507 or equivalent.
Fundamental physical properties of liquids, gases, and ionized systems. Includes selected topics from compressible and incompressible flow, electromagnetic interactions, instabilities, turbulence, nonequilibrium phenomena, kinetics, superfluid mechanics, related experimental techniques, and other topics of current interest in fluid and plasma research.

16:750:610. (S) INTERSTELLAR MATTER (3)
Sellwood. Prerequisite: 16:750:541 or equivalent.
Structure of the interstellar medium: its molecular, neutral atomic, and plasma phases. Radiative transfer, dust, particle acceleration, magnetic fields, and cosmic rays. Effects of supernovae, shock fronts, and star formation.

16:750:611. (S) STATISTICAL MECHANICS (3)
Ioffe. Prerequisites: 16:750:501 and 507.
Statistical methods and probability; the statistical basis for irreversibility and equilibrium; ensemble theory; statistical thermodynamics; classical and quantum statistics; the density matrix; applications of statistical mechanics to nonideal gases, condensed matter, nuclei and astrophysics; fluctuations, nonequilibrium statistical mechanics; kinetic theory.

16:750:612. (S) HIGH-ENERGY ASTROPHYSICS (3)
Hughes. Prerequisites: 01:750:341-342 or equivalent.
Origin and detection of high-energy photons and particles in the universe. Radiation processes in low-density media. Sites of high-energy phenomena in astrophysics, such as supernovae, pulsars, active galactic nuclei and quasars, and processes, such as accretion and shocks.

16:750:613. (S) PARTICLES (3)
Neuberger. Prerequisite: 16:750:502 or equivalent.
Introduction to the concepts and techniques underlying current research in elementary particles. Assumes knowledge of quantum mechanics, scattering theory, and nuclear spectroscopy. Properties of particles and their interactions based on the standard model of strong and electroweak interactions. Conservation laws. Discussion of specific experiments illustrating the standard model.

16:750:615. (F) OVERVIEW OF QUANTUM FIELD THEORY (3)
Prerequisite: 16:750:502 or equivalent.
Lorentz group; relativistic wave-equations; second quantization; global and local symmetries; QED and gauge invariance; spontaneous symmetry breaking; nonabelian gauge theories; Standard Model; Feynman diagrams; cross sections, decay rates; renormalization group.

16:750:616. (S) FIELDS I (3)
Zamolodchikov. Prerequisite: 16:750:615.
Path integral quantization; perturbation theory: dimensional regularization, renormalization; the renormalization group; spontaneous symmetry breaking and effective potential; critical behavior of ferromagnets; f^4 field theory; Yang-Mills perturbation theory.

16:750:617. (F) GENERAL THEORY OF RELATIVITY (3)
Zapolsky. Prerequisites: 16:750:504, 507, or equivalent.
Equivalence principle, tensor analysis with differential forms; review of special relativity and electromagnetism, affine connection and geodesic equation; curvature and geodesic deviation; Einstein field equations; Schwarzschild and Kerr solutions, homogeneous isotropic cosmologies; experimental and observational tests.

16:750:618. (S) APPLIED GROUP THEORY (3)
Prerequisite: 16:750:502 or equivalent.
Abstract groups and their representations, finite groups and Lie algebras; symmetries and currents; symmetric group, in homogeneous Lorentz group, SU(n); classification of Lie algebras, Dynkin diagrams. Spontaneous symmetry breaking mechanisms. Gauge theories.

16:750:619. (F) FIELDS II (3)
Zamolodchikov. Prerequisite: 16:750:616.
Renormalization group applied to Yang-Mills; asymptotic freedom; spontaneous symmetry breaking applied to Yang-Mills; Weinberg-Salam theory; lattice gauge theory; grand unified theories; supersymmetry; strings.

16:750:620. (F) INTRODUCTION TO MANY-BODY THEORY (3)
Kotliar. Prerequisite: 16:750:502 or equivalent.
Second quantization. Elementary excitations. Theory of the Fermi Liquid. Density functional and Hartree-Fock methods. Zero and finite temperature Green's functions. Relation of correlation functions to experimental probes. Perturbation theory. The electron-phonon problem. Collective excitations.

16:750:621. (S) ADVANCED MANY-BODY PHYSICS (3)
Kotliar. Prerequisite: 16:750:620 or equivalent.
Systems of interacting bosons and fermions. Theory of superconductivity and superfluidity. Application of the renormalization group to many-body problems. One-dimensional electron gas. Kondo problem and heavy fermions.

16:750:623,624. ADVANCED STUDIES IN PHYSICS (3,3)
Prerequisite: Permission of graduate director.
Individual studies supervised by a member of the faculty.

16:750:627. (F) SURFACE SCIENCE I (3)
Madey
Introduction to structure and dynamics of clean surfaces, atoms and molecules on surfaces, and interfaces. Topics include atomistic description of geometrical structure, surface morphology, electronic structure, surface composition, and theoretical and experimental bases of modern experimental methods.

16:750:628. (S) SURFACE SCIENCE II (3)
Madey
Kinetics and dynamics of processes at surfaces; structure and reactivity of molecules at surfaces; thermal and nonthermal excitations; magnetic properties. Surfaces of metals, oxides, and semiconductors, as well as solid-solid and solid-liquid interfaces.

16:750:629. (S) OBSERVATIONAL TECHNIQUES (3)
Coté. Prerequisite: 16:750:541 or equivalent.
Introduction to tools and techniques of modern observational astronomy. Survey of instruments and capabilities at current telescope sites around the world and in space. Data reduction methods. Practical experience with Serin Observatory.

16:750:633,634. SEMINAR IN PHYSICS (1,1)
Williams. Prerequisite: Permission of instructor.
Seminars in fields of investigations of current interest.

16:750:636,637. BASICS OF TEACHING PHYSICS (1,1)
Prerequisite: Permission of instructor. Concurrent teaching assignment in physics or astronomy recommended.
Intended for graduate students interested in improving their skills for teaching physics. Topics include teaching goals, results of recent research, lecturing, demonstrations, teaching problem solving, testing, active learning, course development, and teaching difficult concepts in selected areas of physics. Instructor observes the students teaching.

The following courses may be taken in any order. Offered in alternate years.

16:750:681,682. ADVANCED TOPICS IN SOLID-STATE PHYSICS I,II (3,3)

16:750:685,686. ADVANCED TOPICS IN NUCLEAR PHYSICS I,II (3,3)

16:750:689,690. ADVANCED TOPICS IN ASTROPHYSICS I,II (3,3)

16:750:693,694. ADVANCED TOPICS IN HIGH ENERGY PHYSICS I,II (3,3)

16:750:695. ADVANCED TOPICS IN MATH PHYSICS (3)

16:750:699. NONTHESIS STUDY (1)

16:750:701,702. RESEARCH IN PHYSICS (BA,BA)

PHYSIOLOGY AND INTEGRATIVE BIOLOGY 761

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Jianjie Ma, Room 527, UMDNJ–RWJMS, Piscataway (732/235-4550)**

Members of the Graduate Faculty

Juan P. Advis, *Professor of Animal Sciences, CC; Ph.D., South Western; D.V.M., Austral (Chile)*
   Hypothalmic regulation of leutinizing hormone; reproduction physiology
Allan Conney, *Professor of Pharmacology, EMSP; Ph.D., Wisconsin*
   Mechanisms of carcinogenesis and cancer chemoprevention
Daniel Cowen, *Assistant Professor of Psychiatry, UMDNJ–RWJMS; M.D., Ph.D., Case Western Reserve*
   Coupling of 5-HT receptors to cellular signals for protein synthesis
David Denhardt, *Professor of Cell and Molecular Biology, FAS–NB; Ph.D., California Institute of Technology*
   Osteopontin, metalloproteinase inhibitors and their roles in bone biology and cancer
Monica Driscoll, *Associate Professor of Molecular Biology and Biochemistry, FAS–NB/CABM; Ph.D., Harvard*
   Molecular genetics of neurodegeneration; mechanotransduction
Cheryl F. Dreyfus, *Professor of Cell Biology and Neuroscience, UMDNJ–RWJMS/CABM; Ph.D., Cornell*
   Neuronal growth factor and brain development
Huizhou Fan, *Assistant Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., Manitoba*
   Cell signaling of ectodomain shedding and molecular pathogenesis of cancer
Joseph Fondell, *Assistant Professor of Physiology and Biophysics, UMDNJ–RWJMS; Ph.D., New York*
   Transcriptional regulation by nuclear receptors; thyroid and androgen receptors
Michael Gallo, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Albany Medical College*
   Environmental and chemical carcinogenesis; pharmacology and toxicology
Barth Grant, *Assistant Professor of Molecular Biology and Biochemistry, FAS–NB; Ph.D., Princeton*
   Analysis of endocytosis and trafficking in **C. elegans** *and mammalian cells*

Joseph Kedem, *Professor of Physiology and Biophysics, UMDNJ–RWJMS;*
  Ph.D., Hebrew
    Cardiac dynamics and metabolism
George Lambert, *Associate Professor of Pediatrics, UMDNJ–RWJMS;*
  M.D., Illinois
    Environmental factors on childhood growth and development
John Lenard, *Professor of Physiology and Biophysics, UMDNJ–RWJMS;*
  Ph.D., Cornell
    Mechanisms of membrane fusion, sterol utilization in **C. elegans**
Fang Liu, *Assistant Professor of Chemical Biology, EMSP; Ph.D., Harvard*
  TGF- signaling and cancer biology
Peter Lobel, *Professor of Pharmacology, UMDNJ–RWJMS; Ph.D., Columbia*
    Protein targeting; mannose-6-phosphate receptors; cancer prognosis
Jianjie Ma, *University Professor of Physiology and Biophysics, UMDNJ–RWJMS;*
  Ph.D., Baylor
    $Ca_2{}^+$, $Ca_2{}^+$ *channels and related genes in cardiovascular function and cancer biology*
Kenneth H. McKeever, *Associate Professor of Animal Sciences, CC; Ph.D.,*
  McMaster
    Growth factors and glia
Gary F. Merrill, *Professor of Biological Sciences, FAS–NB; Ph.D., Michigan State*
    Regulation of coronary blood flow
Judith Neubauer, *Professor of Pulmonary Medicine, UMDNJ–RWJMS;*
  Ph.D., Rutgers
    Neurobiology of respiratory control; neuronal responses to hypoxia and CO_2
Tim Otto, *Associate Professor of Psychology, FAS–NB; Ph.D., New Hampshire*
    Neurobiology of learning and memory
Jerome Parness, *Associate Professor of Anesthesiology, Pharmacology, and*
  Pediatrics, UMDNJ–RWJMS; M.D., Ph.D., Yeshiva (Einstein)
    Intracellular Ca channel and dantrolene receptor
Nicola C. Partridge, *Professor and Chair of Physiology and Biophysics, UMDNJ–*
  RWJMS; Ph.D., Western Australia
    Signal transduction; molecular endocrinology; metalloproteinases
John Pintar, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS/CABM;*
  Ph.D., Oregon
    Physiology of insulin-like growth factor and genetic analysis of opioid system function
Dipak Sarkar, *Professor and Chairperson of Animal Sciences, CC; Ph.D., Oxford*
    Influences of stress and drug abuse on neuroendocrine and neuroimmune systems
Peter Scholz, *Professor of Cardiac Surgery, UMDNJ–RWJMS; M.D., Basel*
  Medical School
    Cardiovascular physiology and cGMP signaling
Federico Sesti, *Assistant Professor of Physiology and Biophysics, UMDNJ–*
  RWJMS; Ph.D., Genova
    Physiology and structure-function of ion-channels
Sue Shapses, *Associate Professor of Nutritional Sciences, CC; Ph.D., Columbia*
    Metabolism of bone and cartilaginous tissue; osteoporosis
Arabinda K. Sinha, *Associate Professor of Physiology and Biophysics,*
  UMDNJ–RWJMS; Ph.D., California (San Francisco)
    Neurotransmitter up and down regulation
Nancy R. Stevenson, *Associate Professor of Physiology and Biophysics,*
  UMDNJ–RWJMS; Ph.D., Rutgers
    Intestinal digestion and absorption, nutrition, and curricular development
Chih-Cheng Tsai, *Assistant Professor of Physiology and Biophysics,*
  UMDNJ–RWJMS; Ph.D., New York
    Nuclear receptors and their roles in **Drosophila** *development and*
  human diseases
Malcolm Watford, *Associate Professor of Nutritional Sciences, CC;*
  D.Phil., Oxford
    Glutamine metabolism; regulation of glutaminase gene expression
Harvey R. Weiss, *Professor of Physiology and Biophysics, UMDNJ–RWJMS;*
  Ph.D., Duke
    Coronary and cerebral circulation, nitric oxide, myocardial signal transduction
William J. Welsh, *Professor of Pharmacology, UMDNJ–RWJMS;*
  Ph.D., Pennsylvania
    Bioinformatics; computer-aided molecular modeling and drug design
Renping Zhou, *Associate Professor of Chemical Biology, EMSP/EOHSI;*
  Ph.D., California (Berkeley)
    Development of the brain: function of growth factors and their receptors

Programs

This program is jointly sponsored by the UMDNJ–Graduate School of Biomedical Sciences and the Graduate School–New Brunswick of Rutgers University. The program is designed to provide training at the interface of genomics, cell biology, and organismal physiology. Specific topics include molecular endocrinology, cardiovascular research, cancer biology, membrane structure and signal transduction, and the physiological bases of diseases.

Students will enter the physiology and integrative biology program by applying to the Consolidated Programs in Molecular Biosciences, and will receive their degrees from both UMDNJ–Graduate School of Biomedical Sciences, and the Graduate School–New Brunswick of Rutgers University. Most students will receive a full tuition waiver, a stipend, and health benefits for the duration of their studies.

Direct admission to the program will also be considered for students with an advanced background (e.g., students transferring from other universities with advanced courses or an M.S. degree). In such cases, certain credit hours can be transferred toward the graduate degree. In addition, a program leading to a master of science in physiology and integrative biology is offered to meet the needs of students with particular interests. This master's program offers an excellent foundation for future careers in the biomedical professions or in academic or pharmaceutical research. The master's program includes one year of advanced course work and hands-on laboratory experience, followed by a year of intensive laboratory investigation in a mentored environment with a final written thesis.

Aminimum of 72 credits will be required for the Ph.D. degree, of which at least 32 credits must come from formal course work and at least 24 credits must come from thesis research. All required courses, including the core curriculum in the molecular biosciences program and elective courses, offered in the physiology and integrative biology program, must be passed with a grade of *B* or better.

The qualifying examination for admission to candidacy for the Ph.D. degree will consist of two parts: a written exam given at the end of the first year, and an oral exam to be given before the end of the student's second year in the program. The written exam will be based on the material studied in the required core courses of the first year and on a selection of journal articles provided to the students before the exam. The oral exam will consist of a formal written proposal of a project that may or may not be related to the student's thesis research.

Students may also participate in the M.D./Ph.D. program. Such students will be expected to choose a laboratory and research sponsor during the second year of medical school, and begin full time Ph.D. work in the following summer.

Graduate Courses

16:761:507. (F) COMPARATIVE PHYSIOLOGY (3)
Topics of current interest in physiology from a comparative point of view using subject matter derived entirely from recent, original papers.

16:761:508. (S) MOLECULAR AND CELL PHYSIOLOGY (3)
  Prerequisites: Course in physiology or cell biology and biochemistry, or
  permission of instructor.
Lectures on membrane structure, transport phenomena, muscle, nerve, and cell organelles.

16:761:513. (S) CARDIOVASCULAR PHYSIOLOGY (3)
  Merrill. Offered in even-numbered years.
The cardiovascular system in mammals. Coronary circulation, myocardial oxygen consumption, and cardiac arrhythmias.

16:761:515. (S) MEDICAL PHYSIOLOGY (7)
  Stevenson. Prerequisite: Permission of instructor.
Human physiology from the molecular to the systems level. Integration of the systems within the healthy individual. Lectures, small discussion groups, and laboratories in pulmonary and cardiovascular physiology.

16:761:537. (F) EXERCISE PHYSIOLOGY (4)
  Lec. 3 hrs., lab. 3 hrs. Prerequisite: 16:761:501. Offered in alternate years.
Physiological responses associated with acute exercise stress; effects of repeated exercise training. Control mechanisms. Laboratory involves students making measurements of themselves at rest and during exercise; experiments utilizing animals to demonstrate muscle-neural and endocrine functions during exercise.

16:761:546. (S) NEUROENDOCRINOLOGY (3)
  Prerequisites: Mammalian physiology and permission of instructor.
  Recommended: General endocrinology.
Principles of neurosecretion and neuroendocrinology and regulation. The CNS control of hormone secretion and function.

16:761:580. (F) Molecular Basis of Physiology (3)
 Ma
Cell signaling mechanisms, the molecular basis of physiology and genetic diseases, and methodologies used in modern physiological research. Membrane excitability and electrophysiology, Ca signaling and cardiovascular function, nuclear receptors and endocrinology, bioenergetics and cell homeostasis.

16:761:605,606. Advanced Studies in Physiology and
 Integrative Biology (BA,BA)
Research literature review or independent reading.

16:761:701,702. Research in Physiology and Integrative
 Biology (BA,BA)
 Prerequisite: Permission of instructor.

PLANT BIOLOGY 765

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Thomas Leustek, Foran Hall, Cook Campus (732/932-9375, ext. 358)**
Web Site: *http://aesop.rutgers.edu/~plantbio/*

Members of the Graduate Faculty

Faith C. Belanger, *Associate Professor of Plant Biology and Pathology, CC; Ph.D., Illinois*
 Plant molecular biology; hormone-induced secretion
A.J. Both, *Assistant Extension Specialist in Plant Biology and Pathology, CC; Ph.D., Cornell*
 Controlled environment agriculture, crop modeling, systems analysis
Tseh An Chen, *Professor of Plant Biology and Pathology, CC; Ph.D., New Hampshire*
 Plant mycoplasmology and plant biotechnology; plant nematology; nematode ultrastructure
Xuemei Chen, *Assistant Professor of Genetics, WIM; Ph.D., Cornell*
 Identity specification and morphogenesis of stamens and carpels in **Arabidopsis** *flowers*
Chee-kok Chin, *Professor of Plant Biology and Pathology, CC; Ph.D., Alberta*
 Plant cell and tissue culture
Bruce B. Clarke, *Associate Professor of Plant Biology and Pathology and Associate Extension Specialist in Plant Biology and Pathology, CC, and Director, Center for Turfgrass Science; Ph.D., Rutgers*
 Turfgrass pathology; soilborne diseases; disease forecasting and control; mycology
Bill D. Davis, *Associate Professor of Biological Sciences, FAS–NB; Ph.D., Purdue*
 Tissue culture; cell and developmental physiology
Peter Rodney Day, *University Professor of Genetics; Ph.D., London*
 Genetic engineering; genetics of host-pathogen interaction
Hugo K. Dooner, *Professor of Genetics, CC/WIM; Ph.D., Wisconsin*
 Transposons; gene tagging: molecular analysis of meiotic recombination in plants
Edward F. Durner, *Associate Research Professor of Plant Biology and Pathology, CC; Ph.D., North Carolina State*
 Low-temperature stress resistance in tree fruit
Joan G. Ehrenfeld, *Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., CUNY*
 Plant community ecology; ecosystems ecology; pollution impacts
James C. French, *Associate Professor of Biological Sciences, FAS–NB; Ph.D., Cornell*
 Comparative and developmental anatomy; experimental morphology
Chaim Frenkel, *Professor of Plant Biology and Pathology, CC; Ph.D., Washington State*
 Postharvest biology, senescence, fruit ripening, and stress
Cyril R. Funk, *Research Professor of Plant Biology and Pathology, CC; Ph.D., Rutgers*
 Turfgrass breeding
Stephen A. Garrison, *Professor of Plant Biology and Pathology, CC; Ph.D., Illinois*
 Production techniques for vegetables
Randy Gaugler, *Professor of Entomology, CC; Ph.D., Wisconsin*
 Invertebrate pathology; nematology; biological control
Thomas J. Gianfagna, *Research Professor of Plant Biology and Pathology, CC; Ph.D., Cornell*
 Plant growth regulators; physiology of fruit crops
Joseph C. Goffreda, *Associate Professor of Plant Biology and Pathology, CC; Ph.D., Cornell*
 Genetics and breeding; pest resistance in solanaceous crops
Ann B. Gould, *Associate Extension Specialist in Plant Biology and Pathology, CC; Ph.D., Kentucky*
 Ornamental pathology

Steven N. Handel, *Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., Cornell*
 Plant population ecology; pollination biology; ecological genetics
Stephen E. Hart, *Assistant Extension Specialist in Plant Biology and Pathology, CC; Ph.D., Michigan State*
 Weed management in turfgrass and ornamentals
Jean Marie Hartman, *Associate Professor of Landscape Architecture, CC; Ph.D., Connecticut*
 Plant ecology; community ecology; restoration ecology; land planning
Joseph R. Heckman, *Associate Extension Specialist in Soil Fertility, CC; Ph.D., North Carolina*
 Plant nutrition
Melvin R. Henninger, *Professor of Plant Biology and Pathology, CC; Ph.D., Pennsylvania State*
 Cropping systems of potatoes
Bradley I. Hillman, *Research Professor of Plant Biology and Pathology, CC; Ph.D., California (Berkeley)*
 Viral infections of plants and fungi
Bingru Huang, *Associate Professor of Plant Biology and Pathology; CC; Ph.D., Texas Tech*
 Environmental stress physiology of turfgrass
Harry W. Janes, *Research Professor of Plant Biology and Pathology, CC; Ph.D., Rutgers*
 Photosynthetic efficiency and source-sink relationships
Gojko Jelenkovic, *Professor of Plant Biology and Pathology, CC; Ph.D., California (Davis)*
 Genetic manipulation of plants
Randall Kerstetter, *Assistant Professor of Plant Biology and Pathology, CC/WIM; Ph.D., Berkeley*
 Molecular genetics of leaf development and morphogenesis in **Arabidopsis**
Edward G. Kirby, *Associate Professor of Botany, FAS–N; Ph.D., Florida*
 Developmental physiology; tissue culture
Donald Y. Kobayashi, *Associate Professor of Plant Biology and Pathology, CC; Ph.D., California (Riverside)*
 Plant bacteriology; host pathogen interaction; molecular biology
John E. Kuser, *Associate Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., Oregon State*
 Genecological variant; provenance and progeny testing; forest tree propagation
Eric Lam, *Professor of Plant Biology and Pathology, CC; Ph.D., California (Berkeley)*
 Gene regulating mechanisms in plants; development and photomorphogenesis
Michael A. Lawton, *Associate Professor of Plant Biology and Pathology, CC; Ph.D., Oxford*
 Molecular biology; protein kinases
Thomas Leustek, *Professor of Plant Biology and Pathology, CC; Ph.D., Rutgers*
 Stress proteins and cell molecular biology
Bradley A. Majek, *Associate Professor of Plant Biology and Pathology, CC; Ph.D., Cornell*
 Weed science
Pal Maliga, *Professor of Genetics, WIM; Ph.D., Hungarian Academy of Sciences*
 Plant molecular biology; plastid genetics
Charles Martin, *Professor of Biological Sciences, FAS–NB; Ph.D., Florida State*
 Expression and regulation of lipid biosynthetic genes
David R. Mears, *Professor of Bioresource Engineering, CC; Ph.D., Rutgers*
 Engineering systems and environments for greenhouses
Richard H. Merritt, *Professor of Plant Biology and Pathology, CC; Ph.D., Rutgers*
 Environmental and physiological factors affecting crop production in greenhouses
Joachim W. Messing, *University Professor of Molecular Biology and Director of the Waksman Institute of Microbiology; Ph.D., Munich*
 Molecular biology of higher plants; M13 cloning, sequencing gene synthesis
William A. Meyer, *Professor of Plant Biology and Pathology, CC, and Associate Director, Center for Turfgrass Science; Ph.D., Illinois*
 Turfgrass breeding, disease resistance, endophytes
James Murphy, *Associate Extension Specialist in Turfgrass Management, CC; Ph.D., Michigan State*
 Development of management systems that minimize stress and improve turf performance
Elwin R. Orton, Jr., *Research Professor of Ornamental Horticulture, CC; Ph.D., Wisconsin*
 Intra- and interspecific hybridization of trees and shrubs
Peter Oudemans, *Associate Professor of Plant Biology and Pathology, CC; Ph.D., California (Riverside)*
 Fungal plant diseases; population biology of fungi
James A. Quinn, *Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., Colorado State*
 Population ecology; species interactions; evolutionary biology
Ilya Raskin, *Professor of Plant Biology, CC; Ph.D., Michigan State*
 Molecular regulation of plant growth, development, and disease resistance
John N. Sacalis, *Professor of Plant Biology and Pathology, CC; Ph.D., Rutgers*
 Postproduction physiology of floricultural crops
Danny J. Schnell, *Associate Professor of Biology, FAS–N; Ph.D., California (Davis)*
 Mechanism of protein import into chloroplasts

James E. Simon, *Professor of Plant Biology and Pathology, CC; Ph.D., Massachusetts (Amherst)*
Natural plant products, new crops, germplasm, and breeding
Edmund W. Stiles, *Professor of Ecology, Evolution, and Natural Resources, CC; Ph.D., Washington*
Plant-animal interactions; evolutionary ecology
Lena Struwe, *Assistant Professor of Ecology, Evolution, and Natural Resource/Plant Biology and Pathology, CC; Ph.D., Stockholm*
Evolutionary history, diversity, and biogeography of gentians and relatives
Richard E. Triemer, *Professor of Biological Sciences, FAS–NB; Ph.D., North Carolina*
Plant cell biology; phycology; ultrastructure
Nilgun E. Tumer, *Professor of Plant Biology and Pathology, CC; Ph.D., Purdue*
Molecular biology of plant viruses, virus replication, disease resistance, plant transformation
Aurea C. Vasconcelos, *Professor of Botany, FAS–NB; Ph.D., Chicago*
Cell biology; organelle development; plant molecular biology
Nicholi Vorsa, *Professor of Plant Biology and Pathology, CC; Ph.D., Rutgers*
Genetic and cytological studies in blueberries and cranberries
James F. White, *Professor of Plant Biology and Pathology, CC; Ph.D., Texas*
Systematic mycology; studies of endophytes and epibionts
George J. Wulster, *Professor and Extension Specialist in Plant Biology and Pathology, CC; Ph.D., Rutgers*
Root growth and physiology activity
Barbara A. Zilinskas, *Professor of Plant Biochemistry, CC; Ph.D., Illinois*
Photosynthesis; plant molecular biology; algal physiology
Gladis Zinati, *Assistant Extension Specialist in Plant Biology and Pathology, CC; Ph.D., Michigan*
Nutrient and water management for nursery crops, BMPs, filter strips, recycling

Associate Members of the Graduate Faculty

Stacy Bonos, *Assistant Research Professor of Plant Biology and Pathology; CC; Ph.D., Rutgers*
Turfgrass breeding, disease resistance, marker-assisted selection
James J. Polashock, *Research Plant Pathologist, USDA–ARS Fruit Lab, Blueberry/Cranberry Research Center; Ph.D., Rutgers*
Modification of biochemical pathways in plants through biotechnology

Programs

The faculty offers a comprehensive program of study and research and provides specialties in most fields of plant biology. Greenhouse and research facilities and equipment are extensive. Students may do fieldwork in several experiment stations, farms, research stations, a nearby primeval forest ecosystem, an old field, and ancient habitats. Aseminar series of invited scientists provides rich opportunities for students during graduate study.

The faculty offers the master's degree without thesis, the master's degree with thesis, and the doctoral degree. The master of philosophy degree is available to doctoral candidates. Required undergraduate preparation normally includes calculus, general and organic chemistry, physics, general biology or equivalent, genetics, and some botanical training. Some undergraduate training in biochemistry and/or molecular biology is recommended as background for the core curriculum. Students with strong academic records and other evidence of scholarly talents or promise are encouraged to apply. Submission of the Graduate Record Examination score is required, and the biology, biochemistry, or cell and molecular biology subject test score is recommended. Avariety of fellowships and teaching and research assistantships is available.

The graduate faculty includes members from several units, including the departments of plant biology and pathology; biochemistry and microbiology; landscape architecture; ecology, evolution, and natural resources; and environmental sciences at Cook College and the biological sciences department of the Faculty of Arts and Sciences–New Brunswick. Faculty also may be affiliated with the Biotechnology Center for Agriculture and the Environment, the Center for Theoretical and Applied Genetics, the Waksman Institute of Microbiology, and the Center for Interdisciplinary Studies in Turfgrass Science.

Students in the plant biology program may choose from four research and curriculum tracks: (1) molecular and cellular biology, (2) organismal and population biology, (3) horticulture and plant technology, and (4) plant pathology. The core curriculum draws on courses from the four tracks. Additional curriculum requirements are tailored to students' individual interests. The tracks are interwoven, and members of the graduate faculty may be involved in more than one track. Students are encouraged to take courses in more than one track.

Students in the molecular- and cellular-biology track may specialize in photosynthesis, carbon metabolism and partitioning, developmental physiology and genetics, growth regulation, nitrogen metabolism, ion uptake and electrophysiology, molecular biology of subcellular organelles, regulation of gene expression, genetic transformation of plants, senescence, ripening of fruit, seed germination, water relations, tissue culture, comparative or developmental anatomy and morphology, or ultrastructure. Students in the organismal and population biology track may emphasize physiological ecology, population ecology, species interactions, community organization and dynamics, ecosystem dynamics, pollination and reproductive biology, and evolutionary biology. The horticulture and plant technology track focuses on course work and research activity associated with plant biology as it relates to agriculture. Awide diversity of student interests is served by this track, from fundamental investigations of plant function at the molecular level to studies of how environment and biotic stress affect crop production. Students with interests in agricultural biotechnology, plant breeding and genetics, plant physiology, growth and development, and plant interaction with the environment are supported by this track. Among the issues that students in the plant pathology track may address are host/pathogen interactions, epidemiology and control of plant disease, plant virology, bacteriology, mycoplasmology, mycology, molecular biology of plant pathogenic or endophytic microorganisms, and biotechnology.

The master's degree without thesis requires 31 course credits and 1 credit for a paper. The master's degree with thesis requires 26 course credits, 6 research credits, and a research thesis. For the doctoral degree, 72 credits with a minimum of 32 course credits and a minimum of 34 research credits, a research thesis, and one academic year in residence are required. There is no language requirement. Prospective students are invited to visit the program's web site or to write the program director for the *Guide to Graduate Study in Plant Biology* and the *Faculty Research Interests.* Both books provide additional information.

In addition to the graduate courses described below, consult those courses listed under biochemistry, ecology and evolution, environmental sciences, microbiology and molecular genetics, and statistics. Many advanced undergraduate courses (400 level) listed in the *New Brunswick Undergraduate Catalog,* the *Camden Undergraduate Catalog,* and the *Newark Undergraduate Catalog* may be used for graduate credit.

Graduate Courses

16:765:501. (F) INTRODUCTION TO PLANT BIOLOGY (3)
Survey of research topics in plant biology related to faculty research programs.

16:765:502. (S) ADVANCED PLANT PHYSIOLOGY (3)
Prerequisites: Undergraduate plant physiology or equivalent, organic chemistry.
Survey of modern aspects of plant physiology with emphasis on recent literature. Topics covered include mineral nutrition, development, stress physiology, crop physiology, photosynthesis, light responses, water relations, and plant growth regulators.

16:765:506. (S) ELECTRON MICROSCOPY FOR CELL AND MOLECULAR BIOLOGY (3)
Pre- or corequisite: Molecular biology of cells, cell biology, or equivalent.
Principles and techniques of biological electron microscopy. Use and operation of the transmission electron microscope in studying macromolecules, viruses, cells, and tissues.

16:765:507. (F) PLANT-WATER RELATIONS (3)
Prerequisite: 16:765:501 or equivalent.
Whole plant and cell response to water deficits from a physiological perspective. Focus on agronomic plants. Topics include movement of water in the soil-plant-air continuum, water-deficit effects on transpiration, photosynthesis, osmotic adjustment, ion and nitrogen metabolism, hormones, and growth. Techniques involve thermocouple psychrometry, gas exchange, and porometry.

16:765:510. (F) ADVANCED PLANT GENETICS (3)
*Dooner, Jelenkovic. Prerequisite: Undergraduate course in genetics. It is
strongly recommended that students have had a course in biochemistry or molec-
ular biology.*
Classical and molecular genetics of higher plants, including breeding
systems, linkage analysis, recombination, gene and chromosomal
mutations, epigenetics, genetics-based approaches to cloning,
genetic analysis of metabolic pathways, biochemical genetics of
storage compounds.

16:765:512. (S) ANGIOSPERM DIVERSITY (3)
Prerequisite: Introductory botany course.
Cladistics and phylogeny, vegetative structure, physiology, diversity,
plant development, ecology of highly specialized angiosperms.

16:765:513. (S) PLANT MOLECULAR BIOLOGY (3)
*Prerequisites: Undergraduate genetics or equivalent, organic chemistry. Course
in molecular genetics or molecular biology recommended.*
Fundamental and applied aspects of plant molecular biology,
including isolation, structure, and regulation of nuclear and
organellar genes, molecular biology of plant-microbe interactions,
molecular biology of plant development, and plant biotechnology.

16:765:514. (F) PLANT DEVELOPMENTAL AND CELL BIOLOGY (3)
*Prerequisites: Undergraduate courses in plant physiology, molecular biology, or
cell biology; 16:680:580.*
Genetic and cellular aspects of plant development. Regulation of
cell division and differentiation; hormones and signaling mecha-
nisms; stress physiology and cell architecture.

16:765:517. (F) SECONDARY METABOLISM IN PLANTS (2)
Prerequisite: 16:765:514 or equivalent.
Secondary metabolism enzymes and pathways. Metabolites
in economic botany, medicine, industry, and plant taxonomy.
Naturally occurring pesticides.

16:765:518. (S) TOPICS IN PLANT MICROBE INTERACTIONS (2)
Prerequisite: General biology. Recommended: Microbiology.
Comprehensive examination of the interactions between plants
and microorganisms at the molecular, cellular, and organismal
levels in both pathogenic and beneficial interactions.

16:765:520. (S) PLANT BIOCHEMISTRY AND METABOLISM (3)
Prerequisite: Plant physiology or equivalent.
Physiological significance of principal metabolic systems, including
photosynthesis, photorespiration, sulfate and nitrate reduction,
hexose metabolism; synthesis of lipids and lipid pigments, photo-
chemical and hormonal controls, chloroplast development, and
biochemistry of secondary plant products.

16:765:522. (F) APPLIED PLANT SCIENCE STATISTICS (3)
Statistical methods such as experimental design, regression,
ANOVA, covariance, field plot techniques, sampling, factorial
experiments, treatment comparisons, and estimates of effects.

16:765:523. GENETICS OF SEXUALITY (4)
Prerequisites: Introductory genetics and cytology.
Sex-determining mechanisms in selected plant and animal
species; incompatibles and sterilities; developmental and evolu-
tionary aspects.

16:765:524. (S) PLANT GROWTH REGULATORS IN AGRICULTURE (3)
Prerequisite: 11:776:382. Recommended: 16:765:502 and 514.
Chemistry, physiology, and use of naturally occurring and syn-
thetic plant growth substances employed in the management of
horticultural and agronomic crops. Action of auxins, gibberellins,
ethylene-release agents, and growth retardants in relation to the
control of rooting, flowering, fruit ripening, abscission, and the
enhancement of yield.

16:765:525. (S) PLANT MINERAL NUTRITION (3)
Role of essential nutrients in plant growth and development, with
emphasis on the critical levels in plants, yield formation, and
crop quality.

16:765:526. (S) FRUIT RIPENING AND PLANT SENESCENCE (3)
Measurements of plant senescence manifestations, including
fruit ripening.

16:765:528. (F) ADVANCED PLANT BREEDING (3)
Prerequisite: A course in general genetics.
Breeding, self-pollinated, cross-pollinated, and apomictic plants;
role of mutation, polyploidy, and interspecific hybridization in
plant improvement; inheritance of adaptive plant characters;
developing and maintaining improved varieties.

16:765:531. (F) PRINCIPLES OF PLANT PATHOLOGY (3)
Lec. 3 hrs., lab. 3 hrs. Prerequisite: Biology or microbiology.
Fundamental concepts elucidating the nature, cause, diagnosis, dis-
semination, and control of plant diseases. Includes an overview of
all plant disease agents.

16:765:532. (S) ADVANCED PLANT PATHOLOGY (3)
Prerequisite: 16:765:531 or equivalent.
Control and epidemiology of plant disease. Properties, activities,
and physical considerations of fungicides and nematocides and
their application and labeling.

16:765:533. (F) ADVANCED MYCOLOGY (3)
Lec. 2 hrs., lab. 3 hrs. Prerequisite: General mycology or equivalent.
Detailed study of the filamentous and fleshy fungi, with emphasis
on identification, mycological literature, reproduction, and other
special topics.

16:765:535. (F) PLANT VIROLOGY (3)
Lec. 2 hrs., lab. 3 hrs. Prerequisite: 16:765:531 or equivalent.
Current concepts concerning the history, transmission, detection,
identification, biochemistry, classification, ecology, epidemiology,
and control of plant viruses. Special topics or techniques covered.

16:765:536. PLANT DISEASE CLINIC (3)
*Lec./lab. 6 hrs. Prerequisite: General plant pathology or equivalent. Offered only
during the Summer Session.*
Workshop in diagnosing both pathogenic and nonpathogenic plant
disorders, isolation and identification of causal organisms, and
current disease control measures.

16:765:537. PLANT PATHOGENIC BACTERIA (3)
Lec. 2 hrs., lab. 3 hrs. Prerequisite: General plant pathology.
Basic concepts of phytobacteriology, including diagnosis and iden-
tification of plant bacterial diseases, ecology and control of bacte-
ria, pathogenicity, disease physiology, and molecular biology of
pathogenicity factors.

16:765:538. (S) PLANT PATHOGENESIS (3)
Prerequisite: 16:765:531 or equivalent.
Mechanisms of pathogenesis; responses of plants to pathogens
in terms of structure, function, and metabolism; disease resistance,
mechanisms, and genetics of pathogenesis.

16:765:601,602. PROBLEMS IN PLANT BIOLOGY (BA,BA)
Prerequisite: Permission of instructor.
Laboratory and conference course for special problems.

16:765:603,604. SELECTED TOPICS IN PLANT BIOLOGY (BA,BA)
Application of basic concepts of plant growth and development
to the understanding of production problems and their in-depth
study for selected significant topics.

16:765:609,610. SEMINAR IN PLANT BIOLOGY (1,1)
Required of all graduate students.
Advanced topics investigated and presented by students.

16:765:699. NONTHESIS STUDY (1)
For students writing their essays for a nonthesis master's degree.

16:765:701,702. RESEARCH IN PLANT BIOLOGY (BA,BA)
For students working on an experimental research problem for their dissertation.

PLANT PATHOLOGY
(See Plant Biology 765)

PLANT SCIENCE AND TECHNOLOGY
(See Plant Biology 765)

POLITICAL SCIENCE 790

Degree Programs Offered: **Master of Arts, Doctor of Philosophy**
Vice Chairperson, Graduate Studies: **Professor P. Dennis Bathory,**
  Hickman Hall, Douglass Campus (732/932-9321)

Members of the Graduate Faculty

Myron J. Aronoff, *Professor of Political Science and Anthropology, FAS–NB;*
  Ph.D., Manchester; Ph.D., California (Los Angeles)
  Comparative politics (Middle East); political anthropology
Ross K. Baker, *Professor of Political Science, FAS–NB; Ph.D., Pennsylvania*
  Political institutions; Congress; U.S. foreign policy
P. Dennis Bathory, *Associate Professor of Political Science, FAS–NB;*
  Ph.D., Harvard
  Political theory (ancient and medieval); political leadership
Stephen E. Bronner, *Professor of Political Science, FAS–NB; Ph.D.,*
  California (Berkeley)
  Political theory; political economy
Philip H. Burch, Jr., *Research Professor of Public Policy, EJBSPPP;*
  Ph.D., Rutgers
  American political institutions; political economy
Barbara J. Callaway, *Professor of Political Science, FAS–NB; Associate Provost*
  for Academic Affairs in the Social Sciences; Ph.D., Boston
  Comparative politics (Africa); women and politics
Susan J. Carroll, *Professor of Political Science, EIP; Ph.D., Indiana*
  Women and politics; mass politics
Drucilla Cornell, *Professor of Political Science, FAS–NB; J.D., California*
  (Los Angeles)
  Political theory, women and politics
Cynthia R. Daniels, *Associate Professor of Political Science, FAS–NB; Ph.D.,*
  Massachusetts (Amherst)
  Women and public policy; productive politics; political economy of gender
Eric Davis, *Associate Professor of Political Science, FAS–NB; Ph.D., Chicago*
  Comparative politics (Middle East); political economy
Yale H. Ferguson, *Professor of Political Science, FAS–N; Ph.D., Columbia*
  International relations theory/history; Latin America
Leela Fernandez, *Associate Professor of Political Science and Women's and*
  Gender Studies, FAS–NB; Ph.D., Chicago
  Women's studies, comparative politics; political economy; cultural studies
Frank Fischer, *Professor of Political Science, FAS–N; Ph.D., New York*
  Policy analysis
Mary Hawkesworth, *Professor of Political Science and Director of the Center for*
  American Women and Politics, CAWP/FAS–NB; Ph.D., Georgetown
  Feminist theory, women and politics, contemporary political philosophy,
  social policy
Milton Heumann, *Professor of Political Science, FAS–NB; Ph.D., Yale*
  Public law; legal processes; criminal justice and civil liberties
Jane Junn, *Associate Professor of Political Science, FAS–NB; Ph.D., Chicago*
  Methodology
Robert R. Kaufman, *Professor of Political Science, FAS–NB; Ph.D., Harvard*
  Comparative politics (Latin America); political economy
Jan Kubik, *Associate Professor of Political Science, FAS–NB; Ph.D., Columbia*
  East European politics; transitions from communism; politics and culture; local
  politics; forms of social protest
Richard R. Lau, *Professor of Political Science, FAS–NB; Ph.D., California*
  (Los Angeles)
  Mass politics
Susan E. Lawrence, *Associate Professor of Political Science, FAS–NB;*
  Ph.D., Johns Hopkins
  Public law
C. Richard Lehne, *Professor of Political Science, FAS–NB; Ph.D., Syracuse*
  American political institutions
Jack S. Levy, *Professor of Political Science, FAS–NB; Ph.D., Wisconsin (Madison)*
  International relations; foreign policy decision making; causes of war
Barbara C. Lewis, *Associate Professor of Political Science, FAS–NB;*
  Ph.D., Northwestern
  Comparative politics (Africa); women and politics
Roy E. Licklider, *Professor of Political Science, FAS–NB; Ph.D., Yale*
  International relations; foreign policy; military policy
Wilson C. McWilliams, *Professor of Political Science, FAS–NB; Ph.D.,*
  California (Berkeley)
  Political theory; American political thought
Manus I. Midlarsky, *Back Professor of International Peace and Conflict*
  Resolution, FAS–NB; Ph.D., Northwestern
  International relations with emphasis on causes of political violence, including
  war and revolution
Kenneth E. Miller, *Professor of Political Science, FAS–N; Ph.D., Johns Hopkins*
  Comparative politics (Western Europe, Canada)
Gerald M. Pomper, *Professor Emeritus of Political Science, FAS–NB; Ph.D.,*
  Princeton
  American political institutions; mass politics
Edward Rhodes, *Associate Professor of Political Science, FAS–NB;*
  Ph.D., Princeton
  International relations; national security policy; deterrence theory
Alan Rosenthal, *Professor of Public Policy, EJBSPPP; Ph.D., Princeton*
  American political institutions; state politics and legislatures
Gordon J. Schochet, *Professor of Political Science, FAS–NB; Ph.D., Minnesota*
  Political theory; British political thought
D. Michael Shafer, *Professor of Political Science, FAS–NB; Ph.D., Harvard*
  International relations; political economy
Roberta Sigel, *Professor Emerita of Political Science, FAS–NB; Ph.D., Clark*
  American political institutions; mass politics; women and politics
Jay A. Sigler, *Professor of Political Science, FAS–C; Ph.D., Rutgers*
  Public law
Daniel J. Tichenor, *Associate Professor of Political Science, FAS–NB;*
  Ph.D., Brandies
  American national politics
Carl Edward Van Horn, *Professor of Public Policy, EJBSPPP; Ph.D., Ohio State*
  American political institutions; public policy
Harvey Waterman, *Associate Professor of Political Science, FAS–NB;*
  Associate Dean, Graduate School–New Brunswick; Ph.D., Chicago
  Comparative politics (Western Europe); domestic sources of foreign policy
Richard W. Wilson, *Professor of Political Science, FAS–NB; Ph.D., Princeton*
  Comparative politics (China); mass politics
Cliff Zukin, *Associate Professor of Public Policy, EJBSPPP; Ph.D., Ohio State*
  American political institutions; mass politics

Associate Members of the Graduate Faculty

Jocelyn E. Crowley, *Assistant Professor of Public Policy, EJBSPPP;*
  Ph.D., Massachusetts Institute of Technology
  American politics; social policy, civic participation, women and politics
David H. Guston, *Associate Professor of Public Policy, EJBSPPP;*
  Ph.D., Massachusetts Institute of Technology
  Science and technology policy, policy analysis in democratic decision making,
  legislative processes and organization
Michael G. Hagen, *Director of the Center for Public Interest Polling, EIP;*
  Ph.D., California (Berkeley)
  American public opinion, public policy
James Turner Johnson, *Professor of Religion, FAS–NB; Ph.D., Princeton*
  International relations; just war
Arthur Jay Klinghoffer, *Professor of Political Science, FAS–C; Ph.D., Columbia*
  Comparative politics (Soviet)
Beth Leech, *Assistant Professor of Political Science, FAS–NB; Ph.D., Texas A&M*
  American political institutions, public policy
Jonathan Mallamud, *Professor of Law, SL–C; J.D., Harvard*
  Public law; judicial behavior; law and politics
Ruth B. Mandel, *Board of Governors Professor of Politics, EIP; Ph.D., Connecticut*
  Women's participation in American politics

Programs

The graduate program in political science is designed for students
who are seeking a Ph.D. While some students enter the program
after getting a master's degree, exceptional students can win
admittance directly after obtaining a bachelor's degree. Each case is
considered individually, but applicants are more likely to gain
admittance to the program if they have a cumulative grade-point
average of 3.5 or better, particularly in the social sciences.
Applicants also should have high scores on the Graduate Record
Examination and strong letters of recommendation. In awarding
financial aid to entering students, preference is given to those stu-
dents who have been admitted directly to the Ph.D. program.

  Applications for September admission should be submitted
no later than February 1 by students seeking financial assistance.
For everyone else, the deadline is March 1. Transcripts, Graduate
Record Examination scores, three letters of recommendation, and
a writing sample are required.

  The graduate program offers six areas of concentration: political
theory, international relations, comparative politics, women and
politics, public law, and American politics. Candidates for the

Ph.D. select a major area of study from among the six concentrations. To qualify in the major area of study, a student must first pass a written and an oral examination. The written examination is a take-home, open-book examination, and each student has 24 hours to complete it. In addition to the major field, Ph.D. students must work in two minor fields. To qualify in the first minor field, a candidate must pass a written exam. In the second minor field, students must attain a cumulative grade-point average higher than 3.5 in at least three courses. Individual fields may require more than three courses and may designate further specific requirements. Having successfully passed all examinations, the candidate must submit a dissertation proposal within six months.

Typically, students take proseminars in their major and minor areas (9 credits). Grading in proseminars is based mainly on written examinations, as there are no assigned research papers. Ph.D. candidates must take a two-term methods sequence 16:790:532-533 Research Design in Political Science. These courses include elements of research design, quantitative methods, and epistemology of the social sciences. In addition, students must complete three or four research courses (9 to 12 credits) with at least two instructors and take seven to eight electives (21 to 24 credits) inside or outside the program. Before students take their qualifying Ph.D. examinations, they must complete a total of 48 credits of course work and have submitted a significant research paper.

A full description of the program may be found in the brochure *Graduate Program in Political Science,* which is available from the department.

Graduate Courses

16:790:501. PROSEMINAR IN AMERICAN POLITICS (3)
Overview of American politics. Topics include individual and institutional levels, the relationship between citizens and institutions, and the relationships between institutions.

16:790:503. PROSEMINAR: APPROACHES TO COMPARATIVE ANALYSIS (3)
Scope and practice of the field: nature of comparison; approaches to comparison; examples of current research on selected topics.

16:790:505. CONSTITUTIONALISM AND JUDICIAL POLITICS (3)
Role of the federal courts in the American system of democracy. Normative and empirical assessments of the foundations of judicial review and the alleged counter-majoritarian problem; interactions between courts and the other electorally accountable branches; the role of litigants and mobilization processes in the judicial development of doctrine and policy.

16:790:506. (S) CONTEMPORARY CONSTITUTIONAL ISSUES (3)
Current public policy questions explored in the judicial forum, both national and state. A variety of research methods employed.

16:790:507. (S) COMPARATIVE STATE POLITICS (3)
Comparative analysis of the problems of all 50 states. Major factors and political processes that shape the outcomes of state politics. A variety of approaches used in comparative analysis.

16:790:510. PUBLIC POLICY (3)
Introduction to the formulation and implementation of public policy with an emphasis on federal policy making, models for policy choice, and intergovernmental policy problems. A major portion of the course devoted to student projects that analyze the formulation and implementation of a governmental program.

16:790:511,512. PROSEMINAR IN POLITICAL THOUGHT: PLATO TO J.S. MILL (3,3)
Corequisites: 01:790:371, 372.
Intensive study of the history of Western political thought from Plato to J.S. Mill.

16:790:513. PHILOSOPHY OF POLITICAL INQUIRY (3)
Prerequisites: 16:790:511,512, or permission of instructor.
Introduction to major issues in political and social inquiry in the broad perspective of the philosophy of the social sciences. Epistemology, methodology, and historiography in political theory and political science.

16:790:514. AMERICAN POLITICAL THOUGHT (3)
Corequisites: 01:790:375, 376, or permission of instructor.
Major themes in American political thought from the 17th century to the present; emphasis on contemporary movements and ideas, including the new left, the new right, and black thought.

16:790:517. DEMOCRACY, VALUES, AND PUBLIC POLICY: THEORETICAL FOUNDATIONS (3)
Theoretical foundations of public policy in a democracy. Complementarity and conflict between such fundamental values as liberty, equality, justice, security, efficiency, quality (of life), planning, community, fraternity, individuality, and privacy; theoretical implications of distinctions between public and private goods, interests, and values.

16:790:521. PROSEMINAR: THEORIES OF INTERNATIONAL POLITICS (3)
Contemporary approaches to the study of international systems and the behavior of their national subsystems.

16:790:522. THEORIES OF WAR AND PEACE (3)
Survey of the existing theories and explanations of the causes of war and the conditions of peace.

16:790:523. POLITICS OF AFRICA (3)
Problems particular to African political development; colonial experience, one-crop economies, traditional social arrangements, ethnic particularism, and party organization.

16:790:524. MASS MEDIA AND POLITICS (3)
The role, structure, and effects of mass media. Topics include models of mass communication, government regulation, the media as information sources and agents of socialization, media influence on candidate evaluation and voting.

16:790:527. ANCIENT AND MEDIEVAL POLITICAL PHILOSOPHY (3)
Representative primary texts and significant secondary literature, emphasizing major controversies in the interpretation of classical or medieval political philosophy. Readings selected from the works of Plato, Aristotle, Cicero, Augustine, Aquinas, and their respective contemporaries.

16:790:530. EXPLANATIONS OF FOREIGN POLICY (3)
Systematic analysis of factors influencing the foreign policies of states; patterns of relationships.

16:790:531. PROBLEMS IN AMERICAN POLITICS (3)
Selected specific problems in American politics, currently emphasizing state and local elections and campaigning.

16:790:532-533. RESEARCH DESIGN IN POLITICAL SCIENCE (3,3)
Research techniques, an introduction to probability and statistics, the logic of political inquiry, and the philosophy of the social sciences.

16:790:534. THE PRESIDENCY (3)
Introduction to the historical development of the presidency, as well as significant dimensions of contemporary presidential politics. Contending approaches to studying the presidency. Topics include presidential selection; popular leadership; party politics; interest groups and social movements; and relations with Congress, the courts, and the bureaucracy.

16:790:539. POLITICS OF THE MIDDLE EAST (3)
Prerequisite: 16:790:503.
Comparative analysis of nationalist movements, problems of social and cultural change, the Arab-Israeli dispute, and inter-Arab politics. Historical and contemporary perspectives.

16:790:541. POLITICAL CULTURE (3)
Strengths and weaknesses of different political culture approaches; importance of cultural variables for understanding political change.

16:790:542. POLITICAL ANTHROPOLOGY: COMPARATIVE CULTURAL APPROACHES (3)
Approaches to the analysis of culture: semiotics, phenomenology, hermeneutics, structuralism, and critical theory; applications. Meaning in politics: the roles of symbol, myth, metaphor, rhetoric, ritual, religion, and performance.

16:790:544. COLLECTIVE IDENTITY: ETHNICITY AND NATIONALISM (3)
Approaches to conceptualizing collective political identity; comparative analysis of different types of nationalism and its ethnic origins and modernity.

16:790:545. THEORIES IN POLITICAL ECONOMY (3)
Survey of the classical and contemporary literature from Smith and Marx to Lindblom and O'Connor. Normative, theoretical, and empirical implications of competing schools of thought.

16:790:547. FOUNDATIONS OF CAPITALISM AND THE MODERN STATE (3)
Comparative historical development of Euro-American capitalism and state structures, from 1450 through the Industrial Revolution. The role of class relations, state elites, international economic and geopolitical forces.

16:790:548. ADVANCED INDUSTRIAL SOCIETIES (3)
State and economy in Western Europe and North America. Cross-national variations in the relationship among state, class, and public policy.

16:790:551. COMMUNIST AND POST-COMMUNIST POLITICS (3)
Theories of communism (state socialism) and its rise and fall. Dialogues among Western Sovietology, mainstream comparative political science, and theories produced by the "natives" of state-socialist countries.

16:790:552. BUSINESS, POWER, AND POLITICS (3)
Relationship between economic and political power in the United States and other advanced industrial societies. Impact of business interest groups, economic elites, and governmental recruitment on policy making. Issues in power structure analysis.

16:790:553. SPECIAL TOPICS IN POLITICAL ECONOMY (3)
Specialized studies in political economy for advanced students. Topics vary by year and instructor.

16:790:554. COLLECTIVE PROTEST AND SOCIAL MOVEMENTS (3)
Introduction to the literature on collective action, protests, and social movements; recent examples in Eastern Europe; relationships between structure and agency and between structure and culture.

16:790:555. COMPARATIVE POLITICAL ECONOMY (3)
Special reference to the third world. Major periods of sociopolitical transformation: the breakdown of precapitalist social formations, imperialism, decolonization, and revolutionary change. Theories of political economy stemming from the developing world.

16:790:556. PROSEMINAR IN PUBLIC LAW (3)
Introduction to the major literature of the field; recent theories and methods in the study of the judicial process.

16:790:557. RENAISSANCE AND REFORMATION POLITICAL THOUGHT (3)
Prerequisites: 16:790:511,512, or permission of the instructor.
Western political thought from the 14th to the 16th centuries. Machiavelli, his predecessors and contemporaries, and the relationships between politics and religion in the Protestant Reformation.

16:790:558. THE BRITISH TRADITION (3)
Prerequisites: 16:790:511,512.
Social contract theory, utilitarianism, and empiricism in English political thought, with emphasis on the political sources and meanings of works by Hobbes, Locke, Smith, Burke, Hume, and John Stuart Mill.

16:790:559. METROPOLITAN POLITICS (3)
Conflict and consensus with respect to major urban problems: race, schools, housing, transportation, planning, renewal.

16:790:560. SEMINAR IN DOCTRINAL ANALYSIS (3)
Contemporary doctrinal issues; modes of conflict resolution, substantive law findings, and judicial craftsmanship; the interplay of forces at different stages in the adjudicatory process.

16:790:561. POLITICAL ECONOMY OF LATIN AMERICA (3)
Relation between models of capital accumulation and the development of democratic and authoritarian regimes. Special reference to Brazil, Argentina, Chile, and Mexico.

16:790:563. AMERICAN POLITICAL ECONOMY (3)
The organization of American capitalism. Sources and limits of reform. Consideration of American "exceptionalism": impact of party structure, federalism, separation of powers, ethnic and racial cleavages on class formation, and public policy.

16:790:564. COMPARATIVE LEGAL SYSTEMS (3)
Transnational approaches to judicial policy making with emphasis on mechanisms for the protection of basic freedoms; notions of equality under law; federal versus unitary systems in the distribution of powers; and the nature of the regulatory function in diverse societies.

16:790:565. (S) STUDIES IN ADMINISTRATIVE LAW (3)
Inquiry into the lawmaking and judicial function of administrative agencies; critical examination of selected cases drawn from federal and state practice.

16:790:566. THEORIES OF POLITICAL VIOLENCE AND STABILITY (3)
Understanding the origins of domestic violence and instability; relationships with the origins of international warfare; sources and consequences of ethnic conflict emphasized.

16:790:567. EMPIRICAL STUDIES OF PEACE AND WAR (3)
Prerequisite: 16:790:522.
Examination of the empirical evidence on the onset of war, its expansion, the impact of war, and factors associated with peace.

16:790:569. AMERICAN FOREIGN POLICY (3)
Institutions and events that have shaped American foreign policy in the postwar era. Roles of the president, Congress, the bureaucracy, the military, and public opinion. The influence of partisan, economic, and social pressures on the formulation and implementation of policy.

16:790:571. ELECTIONS AND PARTICIPATION (3)
Determinants and consequences of various forms of political participation. Relationship between structures such as electoral systems and citizen behavior. Theories of democracy in light of empirical findings.

16:790:572. POLITICAL PARTIES (3)
Structure and functioning of political parties. Emphasis on empirical studies of membership, nominations, party competition, campaigning, and finance.

16:790:578. FEMINISM IN POSTMODERNITY (3)
Political strategies for achieving gender equality in the context of contemporary feminist debates about the category of women, foundationalism, humanism, identity politics, and essentialism.

16:790:579. The Enlightenment: The Philosophers and Their Critics (3)
Prerequisites: 16:790:511,512, or permission of instructor.
Political thought of Kant, Rousseau, and their contemporaries. Emphasis on Enlightenment responses to the political, educational, and moral problems of modernity.

16:790:580. The 19th Century: Continental Political Thought from Hegel to Marx to Nietzsche (3)
Prerequisites: 16:790:511,512, or permission of instructor.
Topics in the political thought of selected theorists from sequences, including Hegel, Herder, Marx, and Nietzsche; and de Maistre, Bonald, Comte, and Fourier.

16:790:581. Transnational Public Policy (3)
New phenomena that defy the basic assumptions of the dominant realist, state-centric model of the global system, including nonstate actors, transnational issues, and new forms of influence.

16:790:582. Public Opinion (3)
Sources and consequences of public knowledge, beliefs, and attitudes about politics. The measurement of public opinion. Political ideology. Linkages between public opinion and public policy.

16:790:584. (S) Themes in Feminist Theory in Politics (3)
In-depth study of a particular tradition or key debate within contemporary feminist theory. Themes vary.

16:790:585. Social Class and Ideology (3)
Effects of changes in the organization of work and labor markets on political behavior and consciousness. Consequences of race, gender, and ethnicity for class formation.

16:790:586. Psychology of Political Behavior (3)
Introduction to basic explanatory theories at the individual level of analysis. Topics may include personality, attitudes, political cognition, group influences, political socialization, and behavioral decision theory.

16:790:587. Proseminar in Women and Politics (3)
Introduction to approaches, methods, and debates in interdisciplinary feminist scholarship that are useful in analyzing politics.

16:790:588. Gender and Mass Politics (3)
Gender-related influences on political attitudes, voting behavior, and other forms of political participation. Effects of feminist consciousness on attitudes and behavior.

16:790:589. Women and Political Leadership (3)
History, background, recruitment, and performance of women in leadership positions. Women leaders' relationship to power and their impact on public policy and public institutions.

16:790:590. Gender and Political Theory (3)
Analysis of political theory as a signifying practice. The discursive uses of gender in delineating the public sphere, constituting the citizen-subject, and articulating the relations of nation and class.

16:790:591. Gender and Public Policy (3)
Theoretical and policy questions raised by issues related to gender inequality, including welfare and poverty, reproductive rights, violence against women, women and work, health policy, and women and militarism.

16:790:592. Politics, Development, and Women (3)
Political, social, and cultural impact of developmental processes on women. Theories of development and feminist critiques.

16:790:593. Gender and Comparative Politics (3)
Major paradigms used in the study of comparative politics, major critiques of these paradigms put forward by feminist scholars working in the field

16:790:594. Women's Movements in Comparative Perspective (3)
Development and impact of women's movements in cross-cultural perspective. Analysis of the conditions and implications of women's participation in movements such as nationalist, labor, and independent women's movement.

16:790:595. Advanced Survey Research (3)
Sample design, questionnaire construction, interviewer training and evaluation, analysis of survey data, and preparation of proposals for potential users.

16:790:596. Advanced Topics in Women and Politics (3)
Seminar offered on occasion on topics of special interest to students of women and politics.

16:790:597,598. Emerging Trends in Political Science (1,1)
Seminars by eight visiting scholars, each presenting an unpublished paper. Topics vary, but papers are chosen for their empirical and theoretical contributions to the field.

16:790:599. Research Seminar in Political Science Applications of Quantitative Methods (3)
Intensive study and research application of selected methods.

16:790:605. Philosophy of Law and Jurisprudence (3)
The nature of law and its relation to other normative systems; major legal philosophies. Other topics include legal reasoning, the enforcement of morality, and the justification of punishment.

16:790:607. Contemporary Philosophy and Politics (3)
Recent developments in philosophy and their implications for politics and political theory.

16:790:608. Critical Theory (3)
This course will concentrate on those thinkers, usually associated with western Marxism and the Frankfort school, who are the most important representatives of what has come to be known as critical theory.

16:790:610. Research Topics in Political Philosophy (3)
Intensive research seminar for advanced students. Topics vary from year to year.

16:790:611. Advanced Research in Political Economy (3)
Working faculty-graduate student seminar. Presentations of original research.

16:790:612. Seminar in Law and Politics (3)
Intensive study of selected problem areas that may include issues in criminal justice, law and society, and judicial decision making.

16:790:613. Law, Courts, and the Politics of Social Reform (3)
Role of law and courts in the politics of social reform in the United States. Various ways of understanding and investigating the interplay of law and politics in reform projects, with an emphasis on recent developments in the legal academy (e.g., feminist legal theory, critical race theory), as well as in political science.

16:790:614. Advanced Topics in Public Law (3)
Open only to upper-level Ph.D. candidates.
Advanced research seminar in public law provides an opportunity for the design of doctoral research projects and the investigation of their feasibility.

16:790:616. The U.S. Congress (3)
Introduces students to the major components of Congress: congressional elections; the committees; congressional leadership; the legislative process, interest groups, and the relations of Congress with the president and the courts.

16:790:623. Seminar in Constitutional Law (3)
Advanced seminar with emphasis on individual research projects assessing judicial craftsmanship and doctrinal lines of inquiry.

16:790:626. MORALITY AND WAR (3)
The realism-moralism debate, explored through such authors as
Niebuhr, Morgenthau, and Osgood; the role of moral considera-
tions in international affairs examined through cases such as the
use of force across national borders and the human rights issue.

16:790:627. TOPICS IN INTERNATIONAL POLITICS (3)
Open only to advanced students.
Specialized studies and research in international politics. Topics
include mathematical models in international politics and peace
research methods and literature.

16:790:630. INTERNATIONAL POLITICAL ECONOMY (3)
Topics that develop the theory of the structure and dynamic of the
global political economy. Current emphasis on the development
of the post-Depression World War II international economy, espe-
cially relations among OECD countries.

16:790:633. MULTIVARIATE TECHNIQUES (3)
Focus on multiple regression, but also may include categorical
regression, factor analysis, causal modeling, and analysis of vari-
ance. Heavy emphasis on computer applications.

16:790:634. GAME THEORY FOR POLITICAL SCIENTISTS (3)
Introductory course in game theory for political science
graduate students.

16:790:635. FRENCH FEMINIST THEORY (3)
Prerequisite: Permission of instructor.
Linguistic, philosophical, and political tradition of French feminist
thought. Readings drawn from Freud, Lacan, Dérrida, Beauvoir,
Irigaray, Kriesteva, and Wittig.

**16:790:636. DISSERTATION PROPOSALS AND RESEARCH IN WOMEN
AND POLITICS (3)**
Students produce a working draft of a dissertation proposal.
Preparation for the actual process of the dissertation.

16:790:640. RESEARCH SEMINAR ON WAR AND PEACE (3)
Levy, Licklider, Midlarsky. Prerequisites: 16:790:522, 567.
Original research conducted in the area of war and peace.

16:790:644. APPLIED FORMAL MODELS IN POLITICAL SCIENCE (3)
Survey of applied formal models in political science, applications
to specific questions and problems.

**16:790:651. SEMINAR IN PUBLIC ADMINISTRATION AND POLICY
ANALYSIS (3)**
Readings in the specialized literature on bureaucracy, followed
by the presentation and discussion of individual design for
research on a special topic.

**16:790:654. QUANTITATIVE APPROACHES TO INTERNATIONAL
RELATIONS (3)**
Major current attempts to build an empirically based theory
of international politics. Data-generation techniques, methods
of testing, and substantive findings.

16:790:667. RESEARCH SEMINAR IN POLITICAL PSYCHOLOGY (3)
Advanced seminar examining in depth, through individual
research, selected topics in political psychology.

**16:790:670. INDEPENDENT STUDY IN INTERNATIONAL
RELATIONS (3)**

16:790:671. INDEPENDENT STUDY IN PUBLIC LAW (3)

16:790:672. INDEPENDENT STUDY IN WOMEN AND POLITICS (3)

16:790:673. INDEPENDENT STUDY IN POLITICAL THEORY (3)

16:790:674. INDEPENDENT STUDY IN POLITICAL ECONOMY (3)

**16:790:676. INDEPENDENT STUDY IN AMERICAN INSTITUTIONS
AND POLICY (3)**

16:790:677. INDEPENDENT STUDY IN COMPARATIVE POLITICS (3)

16:790:678. INDEPENDENT STUDY IN METHODOLOGY (3)

16:790:680. ADVANCED TOPICS IN INTERNATIONAL RELATIONS (3)
Open only to upper-level Ph.D. students.
Advanced research seminar in international relations, intended to
provide an opportunity for the design of doctoral research projects
and the investigation of their feasibility.

16:790:701,702. RESEARCH IN POLITICAL SCIENCE (BA,BA)
Designed to provide students working on M.A. and Ph.D. theses
with credit for their research.

PSYCHOLOGY 830

Degree Programs Offered: **Master of Science,* Doctor of Philosophy**
Director of Graduate Program: **Professor Louis Matzel,**
Psychology Building, Busch Campus (732/445-2556)
Vice Chair, Graduate Studies: **Professor Lee Jussim,**
Psychology Building, Busch Campus (732/445-2555)

Members of the Graduate Faculty

John R. Aiello, *Professor of Psychology, FAS–NB; Ph.D., Michigan State*
Organizational psychology; privacy; interpersonal processes; nonverbal behavior
Clayton P. Alderfer, *Professor of Psychology, GSAPP; Ph.D., Yale*
Group and intergroup relations; organizational diagnosis; race relations; leadership
Phipps Arabie, *Professor of Marketing, RBS; Ph.D., Stanford*
Multivariate database analysis; social networks
Richard D. Ashmore, *Professor of Psychology, FAS–NB; Ph.D., California
(Los Angeles)*
*Intergroup relations; female and male relations; person perception; identity and
personal problems*
George E. Atwood, *Professor of Psychology, FAS–NB; Ph.D., Oregon*
Theories of personality; psychobiography and psychotherapy
Sidney B. Auerbach, *Associate Professor of Biological Sciences, FAS–NB; Ph.D.,
Wisconsin (Madison)*
Serotonin; biochemistry; electrophysiology and behavior
Marsha Bates, *Associate Research Professor of Psychology, CAS; Ph.D., Rutgers*
Neurocognitive functioning and alcohol
Nicholas J. Belkin, *Professor of Library and Information Studies, SCILS;
Ph.D., London*
Information science and technology
Ian F. Brissette, *Assistant Professor of Psychology, FAS–NB; Ph.D.,
Carnegie Mellon*
The contribution of individual differences and social relationships to health
David M. Brodzinsky, *Associate Professor of Psychology, FAS–NB; Ph.D.,
SUNY (Buffalo)*
Developmental psychology; child clinical, socioemotional development
Brenna H. Bry, *Professor of Psychology, GSAPP; Ph.D., Missouri (Columbia)*
Behavior analysis of adolescent substance use, including family variables
J. Douglas Carroll, *Board of Governors Professor of Management, RBS;
Ph.D., Princeton*
Theory and methods of multidimensional scaling and related techniques
Gretchen Chapman, *Associate Professor of Psychology, FAS–N;
Ph.D., Pennsylvania*
*Medical decision making; physician reasoning; patient preferences and preventive
health behavior*
George H. Collier, *Professor Emeritus of Psychology, FAS–NB;
Ph.D., Indiana*
Ecological and nutritional analyses of learning, motivation, and regulation
Richard J. Contrada, *Professor of Psychology, FAS–NB; Ph.D., CUNY*
Psychosocial factors in physical disease; psychophysiology; stress, self-regulation
Richard DeLisi, *Professor of Educational Psychology, GSE; Ph.D., Catholic*
Cognitive development
M. David Egger, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS;
Ph.D., Yale*
Neurophysiology; neuroanatomy; neurogenetics
Maurice Elias, *Professor of Psychology, FAS–NB; Ph.D., Connecticut*
School-based interventions, prevention, social-emotional intelligence

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* The department does not offer a terminal master's program, although
amaster of science degree must be completed as part of the doctoral
program.

Yakov Epstein, *Professor of Psychology, FAS–NB; Ph.D., Columbia*
Effects of environment on behavior; communication patterns

John L. Falk, *Professor Emeritus of Psychology, FAS–NB; Ph.D., Illinois*
Operant and schedule-induced behavior, psychopharmacology

Jacob Feldman, *Associate Professor of Psychology, FAS–NB; Ph.D., Massachusetts*
Institute of Technology
Theory of categorization; computational vision

Hans Fisher, *Professor of Nutritional Sciences, CC; Ph.D., Illinois*
Alcoholism and neurotransmitter metabolism

Charles F. Flaherty, Jr., *Professor of Psychology, FAS–NB; Ph.D., Wisconsin*
Mechanisms of anticipation; psychopharmacology of reward relativity;
drug interactions

Jerry A. Fodor, *Professor of Philosophy, FAS–NB; Ph.D., Princeton*
Psycholinguistics; cognition

Michael A. Friedman, *Assistant Professor of Psychology, FAS–NB; Ph.D., Yale*
Relation of social interaction to mental and physical health

Charles R. Gallistel, *Professor of Psychology, FAS–NB; Ph.D., Yale*
Behavioral genetic approaches to the molecular basis of memory

Ronald Gandelman, *Professor of Psychology, FAS–NB; Ph.D., Massachusetts*
Behavioral endocrinology

Melvin Lee Gary, *Professor Emeritus of Psychology, FAS–NB; Ph.D., Ohio State*
Prejudice; cognitive styles and social perception; culture and ethnicity

Rochel Gelman, *Professor of Psychology, FAS–NB; Ph.D., California (Los Angeles)*
Concept acquisition; number, cause, kinds of animate and inanimate objects

Arnold L. Glass, *Associate Professor of Psychology, FAS–NB; Ph.D., Stanford*
Semantic memory; psycholinguistics; computer models of syntactic parsing

Leonard W. Hamilton, *Professor of Psychology, FAS–NB; Ph.D., Chicago*
Brain and behavior relationships

Sandra L. Harris, *Professor of Psychology, FAS–NB/GSAPP; Ph.D.,*
SUNY (Buffalo)
Behavioral treatment of autism; impact of autism on family system

Jeannette M. Haviland, *Professor of Psychology, FAS–NB; Ph.D., Michigan State*
Emotional development and the functions of emotion; adolescent
emotion socialization

Judith Hudson, *Associate Professor of Psychology, FAS–NB; Ph.D., CUNY*
Cognitive development; autobiographic memory development of planning skills

Carlton T. James, *Associate Professor of Psychology, FAS–NB; Ph.D., Indiana*
Clinical psychology

Bela Julesz, *State of New Jersey Professor Emeritus of Psychology, FAS–NB;*
Ph.D., Hungarian Academy of Sciences
Visual and auditory perception

Lee Jussim, *Professor of Psychology, FAS–NB; Ph.D., Michigan*
Social perception, interpersonal expectations, and stereotypes

Robert A. Karlin, *Associate Professor of Psychology, FAS–NB; Ph.D., Rutgers*
Hypnotizability; psychotherapy; psychopathology

Eileen Kowler, *Professor of Psychology, FAS–NB; Ph.D., Maryland*
Eye movements; visual perception; cognitive control of movement; attention

Deirdre A. Kramer, *Associate Professor of Psychology, FAS–NB; Ph.D., Temple*
Life-span development; object relational theory; psychobiography; wisdom

Kenneth Kressel, *Associate Professor of Psychology, FAS–N; Ph.D., Columbia*
Mediation of conflict; interpersonal negotiations

Alexander W. Kusnecov, *Assistant Professor of Psychology, FAS–NB;*
Ph.D., Newcastle
Psychoneuroimmunology; immune effects on brain and behavior

Erich W. Labouvie, *Professor of Psychology, CAS; Ph.D., West Virginia*
Life-span methodology; adult socioemotional development

James W. Langenbucher, *Associate Professor of Alcohol Studies, CAS;*
Ph.D., Rutgers
Diagnosis and nosology; socioeconomics of alcohol and alcohol abuse

Richard R. Lau, *Professor of Political Science, FAS–NB; Ph.D., California*
(Los Angeles)
Mass politics

Paul Lehrer, *Professor of Psychology, UMDNJ–RWJMS; Ph.D., Harvard*
Respiratory psychophysiology, stress management, asthma, anxiety

Alan Leslie, *Professor of Psychology, FAS–NB; Ph.D., Oxford*
Early cognitive development; object, number, cause theory of mind; autism

Howard Leventhal, *Board of Governors Professor of Psychology, FAS–NB/*
IHHCPAR; Ph.D., North Carolina (Chapel Hill)
Social psychology of health and illness; emotion theory, age, and illness

Michael Lewis, *Professor of Psychology, UMDNJ–RWJMS; Ph.D., Pennsylvania*
Socioemotional and perceptual-cognitive development

Michael Leyton, *Associate Professor of Psychology, FAS–NB; Ph.D.,*
California (Berkeley)
Group theory in perception, graphics, design, aesthetics, physics, and music

Joseph V. Martin, *Associate Professor of Biology, FAS–C; Ph.D., Southern*
California (Los Angeles)
Hormonal or drug modulation of GABAA receptor function in sleep and waking

Louis D. Matzel, *Associate Professor of Psychology, FAS–NB; Ph.D.,*
SUNY (Binghamton)
Biochemical and biophysical mechanisms of memory induction and storage

Barbara S. McCrady, *Professor of Psychology, GSAPP/CAS; Ph.D., Rhode Island*
Treatment of substance disorders; social support systems and substance abuse

Lorraine McCune, *Associate Professor of Education, GSE; Ed.D., Rutgers*
Developmental and educational psychology

David Mechanic, *University Professor and René Dubos Professor of Behavioral*
Sciences; Ph.D., Stanford
Decision making in medicine and psychiatry

Stanley Messer, *Professor of Psychology, GSAPP; Dean of the Graduate School*
of Applied and Professional Psychology; Ph.D., Harvard
Brief psychodynamic therapy; issues in psychotherapy integration

Edith D. Neimark, *Professor Emerita of Psychology, FAS–NB; Ph.D., Indiana*
Thinking and cognitive development

Daniel Ogilvie, *Professor of Psychology, FAS–NB; Ph.D., Harvard*
Self-perception in interpersonal, work, and role-related contexts

Timothy Otto, *Associate Professor of Psychology, FAS–NB; Ph.D., New Hampshire*
Neurobiology of learning and memory; single unit recording

Nathaniel J. Pallone, *University Professor of Psychology; Ph.D., New York*
Personality and criminal behavior; clinical treatment of criminal offenders

Robert J. Pandina, *Professor of Psychology and Director of the Center*
of Alcohol Studies, GSAPP/CAS; Ph.D., Vermont
Alcohol and drug addiction, neuropsychology, psychopharmacology,
life-span development

Thomas V. Papathomas, *Professor of Biomedical Engineering, SE;*
Ph.D., Columbia
Visual perception; modeling and image processing

Lawrence Pervin, *Professor of Psychology, FAS–NB; Ph.D., Harvard*
Personality theory and research

Donald R. Peterson, *Professor Emeritus of Psychology, GSAPP;*
Ph.D., Minnesota
Dyadic communication; interpersonal relationships

Larissa A. Pohorecky, *Professor of Alcohol Studies, CAS; Ph.D., Chicago*
Alcohol and stress in rats: behavioral and endocrine correlates

Zenon W. Pylyshyn, *Professor of Psychology, FAS–NB; Ph.D., Saskatchewan*
Visual attention; theories of vision and imagery; cognitive architecture

Raymond C. Rosen, *Professor of Psychiatry, UMDNJ–RWJMS; Ph.D., SUNY*
(Stony Brook)
Sexual behavior, sleep disorders, behavioral medicine

Seymour Rosenberg, *Professor Emeritus of Psychology, FAS–NB; Ph.D., Indiana*
Person perception; personal identity

Carolyn Rovee-Collier, *Professor of Psychology, FAS–NB; Ph.D., Brown*
Learning and memory; development processes in human infants; avian regulatory

Laurie A. Rudman, *Associate Professor of Psychology, FAS–N; Ph.D., Minnesota*
Social cognition; attitudes; stereotypes and prejudice

William C. Sanderson, *Associate Professor of Psychology, GSAPP; Ph.D.,*
SUNY (Albany)
Behavior therapy; treatment of anxiety and depression

Louis A. Sass, *Professor of Psychology, GSAPP; Ph.D., California (Berkeley)*
Schizophrenia; assessment; philosophy of psychology

H. Richard Schiffman, *Professor of Psychology, FAS–NB; Ph.D., North Carolina*
Perception of space and time; visual illusions

Charles F. Schmidt, *Professor of Psychology, FAS–NB; Ph.D., Iowa*
Human and machine planning; plan recognition; problem solving and learning

Tracey J. Shors, *Associate Professor of Psychology, FAS–NB; Ph.D.,*
Southern California
Sex differences and effects of stress on memory formation; neurogenesis
and learning

Manish Singh, *Assistant Professor of Psychology, FAS–NB; Ph.D.,*
California (Irvine)
Formal and empirical study of visual object and surface representation

Judith M. Stern, *Professor of Psychology, FAS–NB; Ph.D., Rutgers*
Development of behavior; reproductive behavior and physiology in rats
and women

Karin J. Stromswold, *Associate Professor of Psychology, FAS–NB; Ph.D.,*
Massachusetts Institute of Technology; M.D., Harvard
Cognitive and neural bases of language acquisition and processing

Arthur Tomie, *Associate Professor of Psychology, FAS–NB; Ph.D., Colorado*
Pavlovian conditioning; alcohol and drug abuse; psychopharmacology

David Vicario, *Associate Professor of Psychology, FAS–NB;*
Ph.D., Rockefeller
Sensorimotor processes involved in the acquisition and production of
learned behaviors

George Wagner, *Professor of Psychology, FAS–NB; Ph.D., Chicago*
Neuropsychopharmacology of Parkinson's disease and schizo-
phrenia; neurotoxicology

Neil D. Weinstein, *Professor of Human Ecology and Psychology, FAS–NB;*
Ph.D., Harvard
Preventive health behavior; environmental stress; risk perception

Mark O. West, *Professor of Psychology, FAS–NB; Ph.D., Bowman Gray*
Electrophysiology effect of dopamine system in rat models of drug
abuse, Parkinsonism

David A. Wilder, *Professor of Psychology, FAS–NB; Ph.D., Wisconsin*
Social perception; intergroup relations; time

G. Terence Wilson, *Oscar K. Buros Professor of Psychology, GSAPP; Ph.D.,*
SUNY (Stony Brook)
Behavior therapy; social learning theory; treatment of eating disorders

Robert L. Woolfolk, *Professor of Psychology, FAS–NB; Ph.D., Texas (Austin)*
Psychotherapy, stress, philosophical foundations of psychology

Associate Members of the Graduate Faculty

Beth Adelson, *Associate Professor of Psychology, FAS–C; Ph.D., Harvard*
  Applied and theoretical issues in human problem solving; development of computational models; human-computer interaction-based software systems
James R. Bergen, *Research Staff, Sarnoff Laboratories, Princeton; Ph.D., Chicago*
  Human visual processes and machine vision
Nancy S. Fagley, *Associate Professor of Psychology, GSAPP; Ph.D., Utah*
  Decision making and cognitive processes of professional psychologists
Daniel B. Fishman, *Professor and Director of Psychological Services, GSAPP; Ph.D., Harvard*
  Planning and evaluation of mental-health delivery systems
Barbara Forisha-Kovach, *Professor of Psychology, FAS–NB; Ph.D., Maryland*
  Organizational psychology
Michael A. Gara, *Associate Professor of Psychiatry, UMDNJ–RWJMS; Ph.D., Rutgers*
  Personal identity; identity and psychopathology; person perception
William K. Hallman, *Associate Professor of Human Ecology, FAS–N; Ph.D., South Carolina*
  Risk perception; risk communication; individual and community responses to environmental hazards
Jan S. Handleman, *Educational Director of Douglass Developmental Disabilities Center, FAS–NB; Ed.D., Rutgers*
  Education and treatment of autistic persons
Deanne F. Johnson, *Research Associate in Psychology, FAS–NB; Ph.D., Oregon (Portland)*
  Development and ecological and social modulation of foraging behavior
Ilona Kovacs, *Assistant Professor of Psychology, FAS–NB; Ph.D., Eotvos Lorland (Budapest)*
  Visual perception, development, and plasticity
Sandra Leiblum, *Professor of Psychiatry, UMDNJ–RWJMS; Ph.D., Illinois*
  Female sexuality; menopause; infertility
Robert Matthews, *Professor of Philosophy, FAS–NB; Ph.D., Cornell*
  Psycholinguistics; formal models of language acquisition
James T. Walkup, *Associate Professor of Psychology, GSAPP; Ph.D., New School for Social Research*
  Serious mental illness; combined mental and physical disorders; disability
Michael Wogan, *Associate Professor of Psychology, FAS–C; Ph.D., North Carolina*
  Group psychotherapy
John Worobey, *Associate Professor of Nutritional Sciences, CC; Ph.D., Pennsylvania State*
  Socioemotional development; infant nutrition and behavior

Adjunct Members of the Graduate Faculty

James E. Barrett, *Assistant Vice President, CNS Research, Wyeth-Ayerst Research; Ph.D., Pennsylvania State*
  Behavioral and neurochemical research on drug abuse, anxiety, depression; neuro-chemical correlates of behavioral processes
April Benasich, *Assistant Research Professor of Neuroscience, FAS–N/CMBN; Ph.D., New York*
  Infant perception and cognition; developmental neuropsychology
Elizabeth E. Epstein, *Associate Research Professor of Alcohol Studies, CAS; Ph.D., Connecticut*
  Individual differences among substance abusers, including family history, personality, and comorbid psychopathology; marital therapy for alcoholic males and their spouses; children of alcoholics
Richard Smith-Carliss, *Principal Scientist, Schering-Plough; Ph.D., Northwestern*
  Modulation of the affective component of nociception by neuropeptides

Programs

Areas of specialization include biopsychology and behavioral neuroscience, clinical psychology (APA approved), cognitive psychology, social psychology, intradisciplinary developmental psychology, and intradisciplinary health psychology.

Part-time students are not accepted into the program. New graduate students must have had an undergraduate course in experimental psychology with laboratory and a course in statistics. There is no language requirement.

Specific course requirements and options normally are established by each area. To the greatest extent possible, students' programs are tailored to their career goals. A minimum of 48 course credits and 24 research credits are required in the Ph.D. program.

In addition to the Ph.D. program in clinical psychology, a doctor of psychology (Psy.D.) degree in clinical or school psychology is offered by the Graduate School of Applied and Professional Psychology. This program is described in that graduate school's catalog.

Graduate Courses

16:830:500. SOCIAL PSYCHOLOGY COLLOQUIA (N1)
  Required of all first-year social psychology students.
Series of colloquia, lectures, and panel discussions as an introduction to the discipline and profession of social psychology.

16:830:501,502. NONTHESIS RESEARCH (BA,BA)

16:830:503,504. ADVANCED STUDIES IN PSYCHOLOGY (3,3)
Reading and individual study course; students arrange with members of the staff for direction and guidance; regular conferences scheduled; written and oral reports submitted.

16:830:505. THEORIES AND ISSUES IN DEVELOPMENTAL PSYCHOLOGY (3)
Models and theory in developmental psychology. Emphasis upon metatheoretical and theoretical issues, including theories of cognitive, social, and emotional development.

16:830:506. SOCIAL PSYCHOLOGY (3)
Critical survey of concepts and current research in social psychology. Social perception, attitudes and attitude change, groups.

16:830:507. DEVELOPMENTAL RESEARCH METHODOLOGY (3)
Survey of descriptive and explanatory research methods for the study of behavioral change and development.

16:830:508. RESEARCH METHODS IN SOCIAL PSYCHOLOGY (3)
Critical examination of methodological problems in research involving human subjects, including personality, social psychology, and health psychology. Topics include measurement, experimental and quasi-experimental design, operationalization, and threats to validity. Applications to students' research problems.

16:830:509. PRACTICUM: FIELD AND APPLIED RESEARCH (3)
Practical issues encountered in nonlaboratory settings; procedures and statistical analyses useful when true experimental designs cannot be employed; developing research proposals to meet needs of an organization; issues involved in consultation.

16:830:510. INTRODUCTION TO INDUSTRIAL/ORGANIZATIONAL PSYCHOLOGY (3)
Overview of topics in personnel psychology (predictors, criteria, personnel decisions, interviews, training) and organizational psychology (motivation, job satisfaction, supervision, organizational structure).

16:830:511,512. ADVANCED TOPICS IN DEVELOPMENTAL PSYCHOLOGY (3,3)
Selected topics in developmental psychology, emphasizing theory and research. Offered by different faculty members as a special course in their particular area of expertise.

16:830:513. NEUROLINGUISTICS (3)
  Prerequisite: Graduate student in psychology, linguistics, neuroscience, or philosophy; or permission of instructor.
Topics include functional neuroimaging studies of language (PET, fMRT, MEG), acquired and developmental language disorders, the relationship between language development and neural development, language acquisition after the critical period.

16:830:514. SENSATION AND PERCEPTION (3)
Theoretical and experimental approaches to the perception of form, motion, depth, texture, and color.

16:830:515. COMPUTATIONAL VISION (3)
Introduction to algorithms for computing environmental shape-from-stimulus cues and regularization procedures for choosing optimally economic solutions as related to the perception of surfaces and objects.

16:830:516. HUMAN INFANCY (3)
Current theory and research in infant's socioemotional, motor, perceptual, cognitive, and language development.

16:830:517. INTERPERSONAL BEHAVIOR AND GROUP PROCESSES (3)
Observations of the development of an undergraduate self-analytic group used as the basis for the investigation of issues in the psychology of personality, interpersonal behavior, social structure, and the formation of group cultures.

16:830:518. PERSONALITY ASSESSMENT I (3)
Survey of the logic and rationale of self-report personality assessment procedures and of experimental research procedures. Informal presentation of multivariate data analysis procedures and a practicum in the use of experimental assessment procedures.

16:830:520. PRINCIPLES OF BIOPSYCHOLOGY (3)
Not open to biopsychology majors.
Survey of current theory and data from the fields of neuropsychology, Pavlovian and operant learning, neuropharmacology, and developmental psychobiology.

16:830:521. RESEARCH DESIGN AND ANALYSIS I (3)
Review of basic statistical theory, experimental design, and statistical techniques. Topics include descriptive statistics, probability, z-scores, t-tests, correlation, bivariate regression, one- and two-way analysis of variance, and elementary nonparametric analyses.

16:830:522. RESEARCH DESIGN AND ANALYSIS II (3)
Review of advanced topics in design and analysis, with emphasis on one or more of the following: multiple regression, multi-way analysis of variance, including mixed designs and repeated measures, analysis of covariance, factor analysis, cluster analysis, and bootstrapping techniques.

16:830:523. COMPUTER APPLICATIONS IN PSYCHOLOGY (3)
Designed to introduce psychologists to the use of the computer in the control of experiments, simulation, and complex data analysis.

16:830:524. SENSORY PROCESSES (3)
Theory and data on the senses treated behaviorally and psychologically.

16:830:525,526. DEVELOPMENTAL SURVEY (1,1)
Three classes taught each term in 1-credit units. These may be elected independently.
Comprehensive review of theory, data, and methods in developmental psychology.

16:830:534. PSYCHOLOGY OF DECISION MAKING (3)
Contrasts how decisions are actually made (descriptive theories) with optimal methods for decision making (normative theories); covers psychological research on judgments of uncertainty and individual and group decision making.

16:830:535. LANGUAGE AND COMMUNICATION (3)
Structural properties and processing of language.

16:830:537. ADULT DESCRIPTIVE AND EXPERIMENTAL PSYCHOPATHOLOGY (3)
Systematic consideration of descriptive and experimental psychopathology, consisting of class discussion, student presentations, and research critiques.

16:830:538. CHILD DESCRIPTIVE AND EXPERIMENTAL PSYCHOPATHOLOGY (3)
Descriptive and experimental psychopathology of childhood, covering neurotic, psychotic, and antisocial behavior, learning disabilities, child abuse, and mental retardation. Systematic observation of parent and child interviews and evaluations.

16:830:540. MATHEMATICAL MODELS OF LEARNING, PERCEPTION, COGNITION (3)
Historical and current status of mathematical models of learning, perception, and cognition.

16:830:541. PERSONALITY THEORY (3)
Nature, development, and role of theory in personality; major contemporary theories and relevant evidence.

16:830:542. ATTITUDE ORGANIZATION AND CHANGE (3)
Theories and research data on the formation, structure, and alternation of attitude.

16:830:543. CONDITIONING AND LEARNING (3)
Principles and applications of Pavlovian conditioning, instrumental learning, and stimulus control. Topics include conditioned drug tolerance, learned helplessness, and cognitive processes in animal behavior.

16:830:546. MEMORY AND ATTENTION (3)
Survey of current theories and research in memory and attention.

16:830:547. COMPUTATIONAL MODELS OF COGNITION (3)
Computational approaches to cognition. Historical development of approach; formalisms, tools, and methodological challenges.

16:830:550. LANGUAGE DEVELOPMENT (3)
Theory and research on the acquisition of speech and language by young children.

16:830:551. PERSONALITY AND SOCIAL DEVELOPMENT (3)
Theory and research on personality and social development.

16:830:552. PERCEPTUAL DEVELOPMENT (3)
Effects of early rearing conditions, phylogenetic development, and development of children's and infants' perception of objects, persons, spatial arrays, pictures, and symbols.

16:830:553. STRATEGIES IN COGNITIVE BEHAVIOR THERAPY (3)
Research on and applications of a number of behavioral strategies in psychotherapy. Concentrates on individual, adult, outpatient psychotherapy, treatment of couples, families, and the use of small groups.

16:830:554. DEVELOPMENT OF COGNITIVE PROCESSES (3)
Cognitive development, including memory, language, and thinking.

16:830:556. HUMAN AND ANIMAL AGGRESSION (3)
Attempt to define aggressive behavior and to examine its function.

16:830:558. PSYCHOPHARMACOLOGY: THEORY AND PRACTICE (3)
Neural, neurochemical, and behavioral bases of psychopharmacology. Peripheral and central nervous neurotransmission mechanisms, animal experimental methods. The application of these methods to human problem areas in the behavioral effects of drugs, including learning, activity, dyskinesia, psychosis, tolerance, abuse, aggression, anxiety, and behavioral toxicology.

16:830:560. EMOTION AND MOTIVATION (3)
Biological, cognitive, and social aspects of the nature and basis of emotions and emotion-related behaviors.

16:830:567,568. NERVOUS SYSTEM AND BEHAVIOR I,II (3,3)
Neural bases of reinforcement, motor behavior, and ingestive behavior.

16:830:572. CLINICAL PROSEMINAR I (3)
Basic philosophical issues, current theories of personality, and issues in personality research as they relate to clinical phenomena.

16:830:573. CLINICAL PROSEMINAR II (3)
Open only to clinical psychology students.
Major approaches to personality (psychodynamic, social cognitive) and issues in the field (the unconscious, the self, motivation, personality change). Introduction to the clinical context and the practice of cognitive-behavioral psychotherapy using discussion, demonstrations, and role-playing of techniques such as systematic desensitization, cognitive restructuring, and hypnosis.

16:830:577. HEALTH PSYCHOLOGY (3)
Survey of psychological aspects of physical health/disease. Stress-and-coping theory, stress physiology, and stress moderators. Health-related behaviors; illness cognition, health care utilization, and interactions with the health care system.

16:830:579. DEVELOPMENTAL NEUROSCIENCE (3)
Underlying processes that determine the course of behavioral and physiological development.

16:830:580. HISTORY AND SYSTEMS OF PSYCHOLOGY (3)
Philosophical and scientific antecedents of modern psychology. Psychological systems of psychology, including structuralism, fundamentalism, behaviorism, gestalt, psychoanalysis. Recurrent issues in the history of psychology.

16:830:591. CURRENT TOPICS IN PSYCHOLOGY (BA)
Prerequisite: Permission of instructor.
Review of recent developments within psychology.

16:830:602. PSYCHOLINGUISTICS (3)
Language comprehension and production, including syntactic and semantic analyses.

16:830:610. SOCIAL PSYCHOLOGY OF ORGANIZATIONS (3)
Social psychological analysis of major approaches to organizations, (e.g., classical and open systems), and roles, environment, decision making, leadership, communications, health, conflict, and change.

16:830:611. SEMINAR: PERCEPTION (3)
Selected topics on theory and research in perception.

16:830:612. SEMINAR: SOCIAL PSYCHOLOGY (3)
Prerequisites: 16:830:506, 508, or permission of instructor.
Each section reviews an area of current research interest in social psychology. Topics vary and may include cardiovascular health psychology, health and social behavior, stress and illness, and social cognition.

16:830:613. SEMINAR: CONFLICT AND CONFLICT RESOLUTION (3)
Prerequisites: 16:830:506, 508, or permission of instructor.
Critical examination of major theoretical and empirical approaches to the study of conflict.

16:830:615. TOPICS IN SOCIAL COGNITION (3)
Prerequisites: 16:830:506, 546, or permission of instructor.
Examination of current theoretical and empirical approaches to social behavior from a cognitive orientation.

16:830:616. SEMINAR: PERSONALITY (3)
Prerequisite: 16:830:541 or permission of instructor.
Critical examination of theories of personality, with particular attention to the relationship between emotion and thought.

16:830:620. SEMINAR: THE DYNAMICS OF SMALL GROUPS (3)
Examination of the processes operating in several types of groups, including families, work groups, adult-psychotherapy groups, and children's groups. Includes participation in an experiential group, lectures, and the opportunity to plan and practice consultation and intervention skills with an ongoing group.

16:830:622. INTRODUCTION TO SURVEY RESEARCH (3)
Explores all stages in the survey process (e.g., research design, question construction and survey layout, sampling, interviewing, coding, analysis, and report writing). Covers face-to-face interviews and mail and telephone surveys.

16:830:623,624. THEORY AND PRACTICE OF COGNITIVE BEHAVIOR THERAPY I,II (3,3)
Analysis of the theoretical and clinical foundations of cognitive behavior theory (CBT); clinical practice of CBT with adult disorders.

16:830:627,628. DEVELOPMENTAL LABORATORY I (3,3)
Intensive consideration of problems, methods, data, and theory in selected areas of development.

16:830:631,632. SEMINAR: PROBLEMS OF EXPERIMENTAL PSYCHOLOGY (3,3)
Critical examination of the literature on a relatively circumscribed topic of current research interest in experimental psychology.

16:830:635. SEMINAR: SELECTED TOPICS IN LEARNING (3)
Detailed examination of limited research problem areas in learning.

16:830:636. NEUROENDOCRINE RESPONSES TO STRESS (3)
Psychological factors initiating stress, physiological correlates of stress, and pathological consequences of stress.

16:830:637,638. SEMINAR: COGNITION (3,3)
Selected topics in cognition and cognitive science, including language, memory, attention, problem solving, thinking, and learning.

16:830:639. COGNITIVE ASSESSMENT (3)
Integration of various means of assessment and communication of assessment findings; recent theory, research, principles of measurement, and sociocultural factors relevant to individual cognitive assessment; administration and scoring of individual intelligence tests, interpretation of findings, and use of findings for intervention.

16:830:641. SEMINAR: THINKING (3)
Treats in-depth the literature of circumscribed topics in thinking.

16:830:646. SEMINAR: PROBLEMS IN BEHAVIORAL NEUROSCIENCE (3)
Current problems in the physiological determinants of behavior. Preparation and presentation of student papers.

16:830:651,652. PRACTICUM IN CLINICAL PSYCHOLOGY I,II (3,3)
Second-year students in the clinical Ph.D. program see clients in the program's Psychological Clinic.

16:830:653. SEMINAR: PROBLEMS IN CLINICAL PSYCHOLOGY (3)
Current issues relevant to the technical, as contrasted with the professional, aspects of clinical psychology.

16:830:655,656. PRACTICUM IN CLINICAL PSYCHOLOGY III,IV (3,3)
Third-year students in the clinical Ph.D. program participate one day a week at a mental health or other human service agency.

16:830:657,658. INTERNSHIP IN CLINICAL PSYCHOLOGY (0,0)
Prerequisites: 16:830:655,656 and permission of instructor. Required of candidates for the Ph.D. in clinical psychology.
Eleven months of supervised clinical experience in an approved psychological installation.

16:830:660. PRACTICUM IN DEVELOPMENTAL PSYCHOLOGY (3)
Application of the principles of developmental psychology to a practical problem of development.

16:830:661. NEUROSCIENCE INTERNSHIP (3)
Wagner
Supervised research experience in an industrial setting.

16:830:701,702. RESEARCH IN PSYCHOLOGY (BA,BA)

PSYCHOLOGY, APPLIED AND PROFESSIONAL

(See the catalog of the Graduate School of Applied and Professional Psychology for information about programs that lead to Psy.D. degrees in clinical, school, and organizational psychology.)

PUBLIC HEALTH 832

Degree Program Offered: **Doctor of Philosophy**
Director of Graduate Program: **Dr. George Rhoads, SPH,**
683 Hoes Lane West, Room 135, Busch Campus (732/235-4646)
Codirector: **Dr. Michael Greenberg, Civic Square Building**
(732/932-0387, ext. 673) *or* **SPH, 683 Hoes Lane West, Room 135**
Busch Campus (732/445-0200)
Application and General Information: **732/235-4646**

Members of the Graduate Faculty

Patrick R. Clifford, *Professor of Health Education and Behavioral Science, UMDNJ–SPH; Ph.D., Texas (Houston)*
Alcohol treatment outcomes and drug policy
Michael A. Gallo, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Albany Medical College*
Metabolism of xenobiotics; hormone carcinogenesis; receptor action
Michael Gochfeld, *Clinical Professor of Environmental and Community Medicine, UMDNJ–RWJMS; M.D., Albert Einstein, Ph.D., New York*
Medical surveillance; biomonitoring
Audrey R. Gotsch, *Professor of Health Education and Behavioral Science and Dean, UMDNJ–SPH; Director, Public Education and Risk Communication Division, EOHSI; Dr.P.H., Columbia*
Attitudes and practices regarding health risks; evaluating the training needs of special target groups; environmental health-science education
Lois A. Grau, *Associate Professor of Health Systems and Policy, UMDNJ–SPH; Ph.D., Wisconsin (Milwaukee)*
Gerontology; long-term care; health services utilization
Michael R. Greenberg, *Professor of Urban Studies and Community Health, EJBSPPP; Ph.D., Columbia*
Geography of mortality, morbidity, and risk factors; hazardous waste management
Jun-Yan Hong, *Professor of Environmental and Occupational Health, UMDNJ–SPH; Ph.D., UMDNJ*
Impact of genetic factors on an individual's susceptibility to environmental diseases
Howard Kipen, *Professor of Environmental and Community Medicine and Director of Occupational Medicine, UMDNJ–RWJMS; M.D., California (San Francisco); M.P.H., Columbia*
Clinical epidemiologic studies of occupational asthma and disease diagnosis
Paul J. Lioy, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Rutgers*
Human exposure to toxic substances from single and multiple media; health effects of ozone
Alan C. Monheit, *Professor of Health Systems and Policy, UMDNJ–SPH; Ph.D., CUNY*
Health insurance and employment; private and public insurance, health care use and expenditures; the uninsured population
George Rhoads, *Endowed Professor of Epidemiology and Associate Dean, UMDNJ–SPH; M.D., Harvard*
Epidemiology of perinatal, environmental, and noninfectious health problems
Mark Robson, *Associate Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Rutgers*
Pesticide use; policy; regulation and alternative pest control
Dona F. Schneider, *Professor of Urban Studies and Community Health, EJBSPPP; Ph.D., Rutgers*
Geographic distribution of mortality, disease, and high-risk behavior among chil-dren and young adults
Weichung Joe Shih, *Professor and Director, Biometrics Division, UMDNJ–SPH; Director of Biometrics, CINJ; Ph.D., Minnesota*
Statistical methodology in clinical trials; sequential design and analysis, incom-plete data
Daniel Wartenberg, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., SUNY (Stony Brook)*
Epidemiologic methods; geographic patterns of disease
Clifford P. Weisel, *Associate Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Rhode Island*
Human exposure to organic compounds and trace metals

Junfeng Zhang, *Assistant Professor of Environmental and Occupational Health, UMDNJ–SPH; Ph.D., Rutgers*
Air pollution, exposure measurement and assessment, atmospheric chemistry, health risk assessment, greenhouse gases emissions, policy implications

Associate Members of the Graduate Faculty

Diane J. Abatemarco, *Assistant Professor of Health Education and Behavioral Science, UMDNJ–SPH; Ph.D., Temple*
Maternal and child health issues and factors related to access barriers to care
Cande V. Ananth, *Assistant Professor of Obstetrics and Gynecology, UMDNJ–RWJMS; Ph.D., North Carolina (Chapel Hill)*
Perinatal epidemiology and development of applications of statistical models in human reproduction
Ronald Cody, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ed.D., Rutgers*
Statistical research design
Kitaw Demissie, *Assistant Professor of Epidemiology, UMDNJ–SPH; Ph.D., McGill; M.D., Addis Ababa*
Childhood asthma, perinatal epidemiology, breast cancer
Jane Lewis, *Assistant Professor of Health Education and Behavioral Science, UMDNJ–SPH; Dr.P.H., Texas*
Planning, implementation, and promotion of programs
Jason G. Liao, *Associate Professor of Biometrics, UMDNJ–SPH; Ph.D., Johns Hopkins*
Categorical data analysis, hierarchical models, statistical application in medical research and statistical computing
Shou En Lu, *Assistant Professor of Biometrics, UMDNJ–SPH; Ph.D., Johns Hopkins*
Cohort case-control design and analysis; clustered-failure time data
Stephen Marcella, *Assistant Professor of Environmental and Community Medicine, UMDNJ–RWJMS; M.D., New York*
Cancer control epidemiology and children's health
Jane Miller, *Associate Professor of Urban Studies and Community Health, EJBSPPP/IHHCPAR; Ph.D., Pennsylvania*
Maternal and child health and nutrition; reproductive health; demography
Pamela Ohman-Strickland, *Assistant Professor of Biometrics, UMDNJ–SPH; Ph.D., Cornell*
Analysis with small samples; categorical data; random effect models; clustered failure time data
Omowunmi Y.O. Osinubi, *Assistant Professor of Environmental and Occupational Health, UMDNJ–SPH; M.D., Ibadan*
Smoking cessation intervention in asbestos workers
Lynn Waishwell, *Assistant Professor of Health Education and Behavioral Science, UMDNJ–SPH; Ph.D., Southern Illinois (Carbondale)*
Needs assessment; multicultural issues; models of health behavior change
Bernadette M. West, *Associate Professor of Health Education and Behavioral Science, UMDNJ–SPH; Ph.D., Rutgers*
Community health assessment

Programs

Graduate study in public health has been developed as a joint-degree between the University of Medicine and Dentistry of New Jersey and Rutgers. Faculty members from both institutions, as well as scientists and administrators from industry, government, and public institutions, participate in the teaching program.

The Ph.D. degree requires 72 credits. The areas of concentration are environmental and occupational health, epidemiology, bio-metrics, health education, behavioral sciences, and health systems and policy.

To gain admittance to the courses listed below, Rutgers students must complete the Graduate Exchange Program Form, which is available from the registrar's offices at UMDNJ–School of Public Health or from Rutgers. In addition to these graduate courses, other courses specific to the candidate's specialty area are offered through various programs at Rutgers. Contact the Piscataway office of the graduate program in public health at UMDNJ for a listing of specific courses and other options in public health.

A master's level program and a Dr.P.H. degree also are offered in public health through the Edward J. Bloustein School of Planning and Public Policy and UMDNJ–School of Public Health.

Graduate Courses

BIOM-0530-001. SAMPLING METHODS (3)
Ohman-Strickland
Data collection utilizing stratification, cluster sampling, multistate sampling, systematic sampling, or sampling with unequal proba-bilities of selection may be preferred to simple random sampling.

BIOM-0547-001. LIFETIME DATA ANALYSIS (3)
Lu. Prerequisites: PHCO 0504-001, BIOM 0654-001, BIOM 0661-001.
Survival analysis for life sciences.

BIOM-0550-001. APPLIED LONGITUDINAL DATA ANALYSIS (3)
Liao. Prerequisite: Regression Methods.

BIOM-0606-001. MODELING BINARY-RESPONSE DATA: REVIEW OF THE THEORY AND APPLICATIONS (3)
Ananth. Prerequisite: Permission of instructor.
Applications of regression models suitable for analyzing binary-response data. Models for polytomous and ordinal responses, models for clustered binary responses, and models for analyzing binary-crossover studies also presented.

BIOM-0611-001. BIOCOMPUTING II (3)
Cody. Prerequisites: PHCO-0504-001, BIOM-0654-001.
Advanced uses of SAS and SPSSx, including reorganizing data files, and reading data from tapes and disks.

BIOM-0613-001. THEORY OF STATISTICS I (3)
Probability theory distribution.

BIOM-0614-001. THEORY OF STATISTICS II (3)
Theory of mathematical inference.

BIOM-0615-001. CATEGORICAL DATA ANALYSIS (3)
Descriptive and inferential statistics for univariate and multi-variate categorical data with applications to epidemiological and clinical studies.

BIOM-0654-001. BIOCOMPUTING I (3)
Cody. Prerequisites: PHCO-0504-001; knowledge of MS-DOS
Essential features and use of operating systems. Use of SAS to solve database and statistical problems. Spreadsheet and data-base packages.

BIOM-0660-001. CLINICAL TRIALS: DESIGN AND ANALYSIS OF MEDICAL EXPERIMENTS (3)
Shih. Prerequisites: PHCO-0504-001, BIOM-0654-001, or equivalent.
Concepts, process, logistics, statistical analysis methodology, and the reporting of results. Includes regulatory issues and the process by which a chemical becomes a medicine.

BIOM-0661-001. REGRESSION METHODS FOR PUBLIC HEALTH STUDIES (3)
Lu. Prerequisites: PHCO-0501-001, BIOM-0654-001, or permission of instructor.
Simple and multiple linear-regression models, including polyno-mial regression and analysis of variance (ANOVA) and covariance (ANCOVA) for design of experiments. Binary regression, including logistic regression and applications to case-control studies dis-cussed. Extension to loglinear models for count data also covered. Model building and checking.

BIOM-0687-001. BIOSTATISTICS FOR ENVIRONMENTAL AND OCCUPATIONAL HEALTH (3)
Prerequisites: PHCO-0504-001 and BIOM-0654-001.
Applied statistics for environmental/occupational problems.

BIOM-0690-001. ADVANCED TOPICS IN BIOSTATISTICS (3)

ENOH-0562-001. PESTICIDES AND PUBLIC HEALTH (1)
Robson. Five-week course.
Introduction to the toxicological, health effects, exposure, and policy issues surrounding the use of pesticides in agricultural and residential settings.

ENOH-0588-001. HISTORY OF OCCUPATIONAL DISEASE AND ENVIRONMENTAL HEALTH (3)
Development of ideas and practices in the prevention of workplace exposures and occupational diseases.

ENOH-0594-001. ENVIRONMENTAL AND OCCUPATIONAL TOXICOLOGY (3)
Hong. Prerequisite: Organic chemistry or biochemistry.
Basic language and principles of toxicology and the mechanisms by which xenobiotics damage living systems at the molecular, cellular, tissue, and organ levels.

ENOH-0652-001. ENVIRONMENTAL AND OCCUPATIONAL EPIDEMIOLOGY (3)
Osinubi. Prerequisite: PHCO-0502-001.
Specific epidemiologic approaches to understanding the causation of occupational and environmental health diseases.

ENOH-0656-001. ENVIRONMENTAL RISK ASSESSMENT (3)
Gochfeld. Prerequisite: PHCO-0504-001.
Concepts, language, and methods of risk assessment; role of risk assessment in individual and social decision making.

ENOH-0658-001. ADVANCED ENVIRONMENTAL HYGIENE MEASUREMENTS (4)
Weisel. Prerequisites: 2 years college chemistry, PHCO-0504-001, and a course in air sampling and analysis or principles of industrial hygiene.
Fundamental concepts of data interpretation, quality assurance, and hands-on use of equipment and monitoring procedures in the field.

ENOH-0659-001. OCCUPATIONAL HEALTH PRACTICES (2)
Osinubi
Practical experience leading to certification in spirometry/audiometry.

ENOH-0693-001. (S) ADVANCED PRINCIPLES OF OCCUPATIONAL HEALTH (3)
Osinubi
Workplace hazards, occupational diseases, industrial hygiene, and medical surveillance. Design, implementation, administration, and evaluation of programs.

ENOH-0695-001. ENVIRONMENTAL EXPOSURE MEASUREMENTS AND ASSESSMENT (2)
Zhang. Prerequisites: Calculus, biostatistics, principles of air pollution.
Development of skills for designing exposure studies and basic mathematical tools for estimating exposures.

ENOH-0699-001. PRINCIPLES OF INDUSTRIAL HYGIENE (3)
Prerequisite: PHCO-0503-001.
Skill development for evaluating exposures causing occupational health problems. Emphasis on mathematical techniques to estimate exposures to chemicals, physical agents, and ergonomic hazards facing employees.

EPID-0552-001. INFECTIOUS DISEASE EPIDEMIOLOGY (3)
Rhoads
Properties, characteristics, and mechanisms of transmission of infectious disease; investigation of outbreaks of infectious disease.

EPID-0585-001. DISEASE CLUSTERS: SCIENCE AND POLICY (1)
Wartenberg. Prerequisites: PHCO-0504-001 and PHCO-0502-001.
History and context; methods of cluster investigations.

EPID-0651-001. EPIDEMIOLOGICAL RESEARCH METHODS (3)
Wartenberg
Methods and logistics in the design and conduct of epidemio-logical research.

EPID-0652-001. EPIDEMIOLOGY OF CHRONIC DISEASES (3)
Rhoads
Characteristics of selected chronic diseases. Students learn to design studies to investigate chronic diseases and approaches to primary and secondary prevention.

EPID-0653-001. Epidemiologic Research Methods II (3)
Demissie
Theories, concepts, and principles underlying epidemiologic study designs and analyses.

EPID-0655-001. Seminar in Survival Analysis (3)
Miller. Prerequisites: CORE-5541-001 and REQM-5584-001.
Concepts and skills in the application of event history, including a review of life tables; estimation and interpretation of survival methods as applied to such issues as mortality, marriage, and nursing home admission.

EPID-0695-001. Classic Papers in Public Health (1)
Schneider. Prerequisites: PHCO-0502-001, PHCO-0504-001.
Books, essays, journal articles, and public documents that have had a profound impact on public health.

HEBS-0651-001. Health Education Planning and Evaluation (3)
Abatemarco. Prerequisite: CORE-5550-001.
Introduction to development of health education and health promotion programs.

HEBS-0653-001. Modifying Health Behaviors: Theory and Practice (3)
Clifford. Prerequisite: PHCO-0505-001.
Concepts, strategies, and skills for modifying health-related behaviors and for influencing environments and cultures to provide more health support.

HEBS-0655-001. Methodologies and Materials in Health Education (3)
Lewis. Prerequisites: PHCO-0505-001; HEBS 0651-001 or HEBS-0653-001.
Selection and evaluation of appropriate health education methodologies and materials for achieving program goals and objectives.

HEBS-0665-001. Survey Research Methods (3)
Prerequisite: PHCO-0504-001.
Major methods and techniques in the use of surveys for program development, evaluation, and research.

HEBS-0679-001. Health/Risk Communication (3)
Lewis. Prerequisite: PHCO-0505-001.
Concepts of public health communication and risk perception, and communication emphasis on media coverage of health-related information.

HEBS-0680-001. Doctoral Research Seminar in Health Education and Behavioral Science I (1)
Current behavioral science research issues, research interpretation.

HEBS-0681-001. Doctoral Research Seminar in Health Education and Behavioral Science II (2)
Current behavioral health science research issues; research interpretation, presentation, and facilitation of discussion.

HEBS-0682-001. Evaluation Research Methods (3)
Clifford

HSAP-0519-001. Health Economics (3)
Prerequisites: PHCO 0501-001 and PHCO 0504-001.
Principles of macroeconomics applied to the special features of the health care market.

HSAP-0563-001. Introduction to Outcomes Research (3)
Demissie, Marcella
Study of patient outcomes, medical outcomes, and economics outcomes related to health and health care: quality-of-life issues and assessment tools; and measures of morbidity, mortality, treatment, and severity of disease.

HSAP-0617-001. Health Services Research Evaluation (3)
West. Prerequisites: PHCO-0501-001, PHCO-0502-001, PHCO-0504-001.
Systematic approaches to the evaluation of health services programs, building on prior knowledge of research methods in biostatistics and epidemiology, and issues in health services administration.

HSAP-0623-001. Overview of Managed Care (3)
Prerequisite: PHCO 0501-001.
Introduction to the range of organizational and financial models that characterize managed care organizations (MCOs).

HSAP-0661-001. Health Care Policy (3)
Monheit. Prerequisite: PHCO 0501-001.
Health care politics and policy in the United States as a function of American political values, government structure and process, and the goals of the relevant stakeholders.

PHCO-0501-001. (F) Health Systems and Policy (3)
Grau. Required core course.
Overview of health care in the United States: social, political, and economic issues; organization and financing of health care services. Examines the private practice of medicine and health maintenance organizations; ethical, legal, and policy issues; trends in health care organization in the United States.

PHCO-0502-001. (S) Principles and Methods of Epidemiology (3)
Schneider, community experts. Required core course.
Introduction to the definitions, language, and approaches of epidemiologists.

PHCO-0503-001. (F) Introduction to Environmental Health (3)
Gochfeld, Robson, Zhang. Required core course.
Variety of ways in which environmental factors influence human health and technology available for managing such factors and preventing disease; physiological interaction of humans and their environment; air, water, physical factors, biological factors, and social factors. Special topics include asbestos, lead and mercury, radiation, noise, organic solvents, biocides, particulate air pollution, toxic wastes, water treatment, and neurobehavioral and reproductive hazards; community perceptions of, and responses to, hazards.

PHCO-0504-001. Introduction to Biostatistics (3)
Ohman-Strickland. Prerequisite: Pretest. Required core course.
Brief introduction to fundamental concepts in descriptive and inferential statistics and to quantitative and computer methods. Basic methods, including t-test, chi-square, nonparametric tests, F-tests.

PHCO-0505-001. Health Education and Behavioral Science in Public Health (3)
Waishwell
Learning and behavioral sciences theories that provide the framework for the practice of health education and interventions.

PHEL-0762-001. Controversies and Debate on Current Issues in Public Health (0)
Wartenberg. For doctoral students only.
Issues in the current public health scientific literature; oral presentations.

PUBLIC POLICY

(See the catalog of the Edward J. Bloustein School of Planning and Public Policy for information about master's degree programs in this area.)

QUATERNARY STUDIES 841

Program Offered: **Certificate in Quaternary Studies**
Director of the Certificate Program in Quaternary Studies:
  Professor Gail M. Ashley, Department of Geological Sciences,
  239A Wright-Rieman Laboratories, Busch Campus
  (732/445-2221, 2044)
Email: *gmashley@rci.rutgers.edu*

Participating Faculty

The following members and associate members of the graduate
faculty, identified more fully under their respective programs,
are among those who participate in the certificate program
in Quaternary studies:

S. Anton, *Anthropology*
G. Ashley, *Geological Sciences*
R. Blumenschine, *Anthropology*
L. Burckle, *Geological Sciences*
S. Cachel, *Anthropology*
P. Falkowski, *Geological Sciences*
C. Feibel, *Anthropology*
J. Harris, *Anthropology*
D. Kent, *Geological Sciences*
J. Miller, *Environmental Sciences*
K. Miller, Sr., *Geological Sciences*
A. Robock, *Environmental Sciences*
Y. Rosenthal, *Geological Sciences*
K. Scott, *Ecology and Evolution*
R. Sherrell, *Environmental Sciences*
C. Swisher III, *Geological Sciences*
J. Wright, *Geological Sciences*

Certificate Program

Quaternary studies gives students the chance to study the earth
and its inhabitants over the last few million years. It is an interdis-
ciplinary program that awards a certificate of achievement to stu-
dents who are pursuing a master's or doctoral degree in their
major field. Participating graduate programs are anthropology,
ecology and evolution, environmental sciences, geography, and
geological sciences. Students must fulfill all degree requirements
in their major program and take two courses in other participating
programs that focus on the Quaternary period. In addition, the cer-
tificate requires enrollment for one term in 16:841:501 Quaternary
Studies Seminar. If a thesis is required for the degree, it should
focus on the late Cenozoic or Quaternary time period.

Graduate Courses

16:841:501. QUATERNARY STUDIES SEMINAR (3)
A multidisciplinary course focused on specific questions or prob-
lems related to the Quaternary time period. Participating faculties
have specialties in geology, anthropology, biology, climatology,
oceanography, paleontology, and soils.

16:841:503. PEDOLOGY (3)
General processes and paradigms of soil formation. Soil taxonomy,
soil chemistry, clay mineralogy, and the importance of biological
processes in soil genesis. Interpretation of paleoclimate from the
soil record.

16:841:504. MODERN LINKS TO ANCIENT LIVES (3)
Using contemporary observations and laboratory and field experi-
ments in a variety of habitats and ecosystems to understand the
impact of humans and natural processes on the geological and
archaeological record.

16:841:505. PALYNOLOGY (3)
Morphology and taphonomy of fossil pollen, especially with refer-
ence to Quaternary sediments. Use of pollen analysis to reconstruct
paleoenvironments. Emphasis on field sampling, laboratory analy-
ses, and interpretation of results.

16:841:506. ISOTOPES IN THE PALEOENVIRONMENT (3)
Application of isotope geochemistry to paleoenvironmental studies
in hydrology, geology, anthropology, ecology, and paleontology.
Emphasis on understanding conceptual basis, limitations, and
potential of isotopic studies.

16:841:507. HOLOCENE SEA LEVEL (3)
Coastal environments and processes and their relationship to the
Holocene stratigraphic record; interpretation with respect to global
climate change. Use of stratigraphic analyses to reconstruct coastal
environments. Emphasis on field sampling, laboratory analyses,
and data.

RUSSIAN, CENTRAL AND EAST EUROPEAN STUDIES 859

Program Offered: **Certificate in Russian, Central and
  East European Studies**
Director of the Certificate Program: Professor Jan Kubik,
  Center for Russian, Central and East European Studies,
  172 College Avenue, College Avenue Campus (732/932-8551)

Participating Faculty

The following members of the graduate faculty, identified more
fully under the subject headings indicated, are among those who
participate in the certificate program in Russian, Central and
East European Studies:

József Böröcz, *Sociology*
Belinda Davis, *History*
David Foglesong, *History*
Ziva Galili, *History*
Peter Golden, *History*
Jochen Hellbeck, *History*
Jan Kubik, *Political Science*
Gerald Pirog, *Comparative Literature*
Joanna Regulska, *Geography*
Stephen Reinert, *History*
Robert Stuart, *Economics*
Gabor Vermes, *History*

Certificate Program

Students with an interest in Russia or in central and eastern
Europe may pursue a concentration in this area as part of their reg-
ular degree studies. Students who fulfill the following require-
ments may be awarded a Certificate in Russian, Central and East
European Studies upon completion of their degree. In many cases,
the certificate requirements may be used to satisfy the student's
own graduate-degree requirements.

Certificate Requirements

1. Completion of three courses (9 credits) in Russian, Central and
   East European subjects, with a grade of *B* or better. These
   courses must be taken in disciplines other than the student's
   degree program. Of these three courses, no more than two can
   be in any one discipline. Only one can be in the 300–400 level,
   subject to approval by the program's director.
2. Completion of a yearlong seminar (6 credits) offered by the
   Center for Russian, Central and East European Studies.
3. Completion of a major research paper under the guidance
   of two participating faculty members.
4. Proof of proficiency in one of the languages of the region.
   Language tests are administered by the Center for Russian,
   Central and East European Studies.

Only students already admitted to a degree program in the
Graduate School–New Brunswick may participate in the certificate
program. Courses in Russian, Central and East European Studies
are offered by participating faculty through their departments
and graduate programs. Further information is available from the
director of the certificate program.

Graduate Courses

16:859:501,502. RUSSIAN, CENTRAL AND EAST EUROPEAN STUDIES SEMINAR (3,3)
Yearlong seminar that examines the political, economic, and social transition in Russia and in Central and Eastern Europe from various perspectives. Theme of the seminar changes annually. Taught by Rutgers faculty members and visiting faculty from the region.

SOCIAL WORK 910

Degree Program Offered: **Doctor of Philosophy**
Director of Graduate Program: **Professor Donald T. Dickson, School of Social Work, 536 George Street, College Avenue Campus (732/932-6967)**

Members of the Graduate Faculty

Eleanor L. Brilliant, *Professor of Social Work, SSW; D.S.W., Columbia*
Social policy, organizations, women, and international philanthropy
Michael J. Camasso, *Associate Professor of Social Work, SSW; Ph.D., Pennsylvania State*
Public welfare; social work knowledge development; quantitative methodologies
Stephen Crystal, *Research Professor of Social Work and Sociology, SSW/IHHCPAR; Ph.D., Harvard*
AIDS; long-term care; homelessness; longitudinal data analysis
Mary Edna Davidson, *Dean and Professor of Social Work, SSW; Ph.D., Brandeis*
Child welfare; advocacy research; equity analysis of public social policy
Donald T. Dickson, *Professor of Social Work, SSW; Ph.D., Michigan*
Law; child welfare; mental health; administration
Antoinette Farmer, *Associate Professor of Social Work, SSW; Ph.D., Pittsburgh*
Parenting behavior, kinship care; AIDS knowledge and prevention; evaluation of social work practice
Paul Glasser, *Professor of Social Work, SSW; Ph.D., North Carolina*
Family theory; marital and family therapy; small-group theory and practice
Raymond Sánchez Mayers, *Associate Professor of Social Work, SSW; Ph.D., Brandeis*
Financial management in nonprofits; administrative issues; Hispanic issues
David Mechanic, *University Professor and René Dubos Professor of Behavioral Sciences; Ph.D., Stanford*
Medical sociology; evaluation research and social policy
Kathleen J. Pottick, *Associate Professor of Social Work, SSW/IHHCPAR; Ph.D., Michigan*
Child and adolescent mental health and psychiatric service delivery system
Jerome C. Wakefield, *Professor of Social Work, SSW/IHHCPAR; D.S.W., California (Berkeley)*
Conceptual and theoretical foundations of mental health services
Allison Zippay, *Associate Professor of Social Work, SSW; Ph.D., California (Berkeley)*
Poverty and employment policy; community development; social networks

Associate Members of the Graduate Faculty

Judith Baer, *Assistant Professor of Social Work, SSW; Ph.D., Houston*
Life-span development; adolescent development
Laura Curran, *Assistant Professor of Social Work, SSW; Ph.D., California (Berkeley)*
Family and child policy and practice; welfare policy; social welfare history/theory; gender and sexuality
G. Lawrence Farmer, *Assistant Professor of Social Work, SSW; Ph.D., Florida International*
Evaluation of social programs; psychological and psychiatric assessment; quantitative-data analysis
Blanche Grosswald, *Assistant Professor of Social Work, SSW; Ph.D., California (Berkeley)*
Economics of social welfare and policy analysis
Chien-Chung Huang, *Assistant Professor of Social Work, SSW; Ph.D., Columbia*
Child support, social assistance, poverty, and income redistribution
Michael C. LaSala, *Assistant Professor of Social Work, SSW; Ph.D., SUNY (Albany)*
Clinical social work; gay and lesbian issues; marriage and family therapy
Shari Munch, *Assistant Professor of Social Work, SSW; Ph.D., Michigan State*
Health care; women's health care; perinatal ethics and bereavement
Jonathan Prince, *Assistant Professor of Social Work, SSW; Ph.D., California (Berkeley)*
Child welfare and mental health services; history of adult mental health care
Robert James Reid, *Assistant Professor of Social Work, SSW; Ph.D., Columbia*
Substance abuse; HIV/AIDS prevention; cost benefit analysis
Mark Schmitz, *Assistant Professor of Social Work, SSW; Ph.D., Iowa*
Mental health; social psychology; family; life course and aging sociology
Sharon H. Smith, *Assistant Professor of Social Work, SSW; Ph.D., Pennsylvania*
Social gerontology; methods of direct practice; child welfare

Lynn A. Warner, *Assistant Professor of Social Work, SSW; Ph.D., Michigan*
ATOD; mental health; epidemiology and social policy

Programs

The Graduate School–New Brunswick, in cooperation with the School of Social Work, offers programs leading to a Ph.D. in social work. Programs for students seeking a master of social work are provided by the School of Social Work. Students may find descriptions of those courses in the catalog of that professional school.

The doctoral program in social work prepares students for advanced research in social work and for leadership roles in social welfare organizations.

The program is designed for students who have earned an M.S.W. or a master's degree in a closely related field. The program's two tracks, direct practice and social policy and administration, emphasize theory development and research. Each track requires students to take courses in research and statistics, plus courses related to the specific track. Students also take electives and one or more courses in a cognate discipline outside social work. Finally, there are courses to help students become computer literate in social science research and statistical analysis.

In addition to course work, students must complete a research internship, take a qualifying examination, and submit a dissertation. The research internship, which is done under the direction of a faculty member, prepares students to do the independent research needed for the dissertation. The qualifying examination ensures that a student has acquired the necessary background before starting dissertation research. Only when all other requirements are met do students research and write their dissertation under direction of a faculty member and a doctoral committee.

The curriculum policy of the doctoral program in social work gives students maximum latitude to design their own programs of study. Preparation includes 6 credits of graduate-level statistics courses, 6 to 9 credits in the social work major, 6 to 9 credits of electives, and 3 credits in the social sciences or other courses outside social work. Once a student has completed satisfactorily 12 credits of course work, he or she may transfer as many as 18 credits from the prior master's program.

Students take their qualifying examination after they have completed 30 credits of course work. Each is admitted to candidacy for the degree after his or her research proposal has won approval from the committee. While working on his or her dissertation, a student is required to register for 24 research credits. It takes 72 credits to earn a Ph.D.

The residency requirement calls for students to register for a minimum of 30 credits of approved course work. There are three ways of meeting this requirement. The most intensive plan calls for students to complete all their course work in one year of residency at the New Brunswick campus. Under this option, students take four courses each term and participate in a research internship during the summer of that year. Other requirements for the degree, such as the qualifying examination and dissertation, are completed after the first year, and do not require residency.

A two-year option is designed for people who want to obtain a doctorate in the middle of a career. Under this plan, students spend one full day each week on campus, completing the 10 required courses in two years. Most students choosing this option require an additional term to take the qualifying examination and prepare a dissertation proposal. While the time needed to complete a dissertation varies, most students take two to four years.

The program offers a post-M.S.W. honors option for students who complete the M.S.W. program with outstanding records but who lack practical experience after getting their advanced degree. These students are encouraged to do social work while in the doctoral program. This plan enables students, while working on a doctorate, to acquire the two years of post-M.S.W. experience needed to qualify for a faculty position.

Admission requirements include an M.S.W. or a closely related master's degree. Two years of post-M.S.W. practice experience is preferred for all except those enrolled in the post-M.S.W. honors option.

Graduate Courses

16:910:637. (F) QUANTITATIVE RESEARCH METHODS (3)
Knowledge and skills needed to carry out independent doctoral-level research in social work. Identification and study of state-of-the-art methods of design and measurement; qualitative and quantitative formulations; data gathering, processing, analysis, and interpretation.

16:910:638. (F) ADVANCED STATISTICAL METHODS I (3)
Prerequisite: 16:910:637.
Analytic and measurement strategies fundamental to multivariate model testing in policy, administration, and direct practice research. Topics include tabular and loglinear analysis, multiple regression, analysis of covariance, and analysis of variance in its principal forms. Multiple indicators and measurement approaches, such as exploratory and confirmatory factor analysis.

16:910:639. (S) ADVANCED STATISTICAL METHODS II (3)
Prerequisite: 16:910:638.
Use of multivariate, quantitative methods. Employing multiple dependent variables, nonlinear relationships, mediator effects, instrument variables, and multilevel analysis.

16:910:640. (S) QUALITATIVE RESEARCH METHODS (3)
Examination of the methods of collecting, analyzing, presenting, and applying qualitative data. History and evolution of qualitative research methods; theoretical orientations; data-collection methods, including ethnography, participant observation, in-depth interviewing, focus groups, and archival analysis; methods of data analysis; and research applications, including theory development and program design and evaluation.

16:910:644. (S) CURRENT PERSPECTIVES (3)
Prerequisite: 16:910:687.
Theories and models of intervention used in social work direct practice. Applications.

16:910:646. (S) FAMILY THEORY AND PROGRAM DEVELOPMENT (3)
Study of family theory and its relationship to program development at different levels of practice and social planning. Geared toward both a policy planning and intervention perspective, as well as a sociological interest in socialization and the study of deviance.

16:910:647. (F) SOCIAL POLICY ANALYSIS (3)
Paradigms, methods, and strategies for the analysis of policy from social work, economics, sociology, political science, public administration, policy sciences, and planning.

16:910:649. (F) MENTAL-HEALTH POLICY (3)
Major issues in mental-health policies and programs in socioenvironmental context.

16:910:650. (S) PROBLEMS IN HEALTH AND SOCIAL POLICY (3)
Selected critical issues in the delivery of human services; application of social research to policy. The policy research process. Topics may include care of the aging and the health policy challenge posed by the AIDS epidemic.

16:910:682. (F) ADVANCED INDIVIDUAL STUDIES IN SOCIAL WELFARE (3)
Study in depth, and on an individualized basis, various areas of social policy, social planning, social administration, or direct intervention.

16:910:683. (S) ADVANCED INDIVIDUAL STUDIES IN SOCIAL WELFARE (3)
Provides an opportunity to specialize in a specific area of policy analysis, social planning, social administration, or direct intervention, on an individualized basis.

16:910:687. (S) THEORY DEVELOPMENT IN SOCIAL WORK DIRECT PRACTICE (3)
The relative places and contributions of theoretical conceptualization, "practice wisdom," and descriptive and prescriptive research.

16:910:694. (S) SOCIAL WORK ORGANIZATIONS (3)
Applicability of organizational theories and concepts from the social sciences for analysis of human service organizations; strategies and performance with clients and constituents. Criteria and procedures for organizational assessment and case studies of public and private social welfare organizations. Use of various paradigms for critical analysis of organizational culture, environmental interactions, resource dependency, policy impact, and program implementation.

16:910:701,702. DISSERTATION RESEARCH (BA,BA)
Independent research study related to proposed dissertation, with assistance of appropriate faculty. Dissertation seminar.

16:910:703,704. RESEARCH INTERNSHIP (BA,BA)
Independent research internship under guidance from the faculty adviser to develop a dissertation proposal.

SOCIAL WORK: ADMINISTRATION, POLICY AND PLANNING, AND DIRECT PRACTICE
(See the catalog of the School of Social Work for information about the M.S.W. degree.)

SOCIOLOGY 920

Degree Programs Offered: Master of Arts, Doctor of Philosophy
Director of Graduate Program: Professor Richard Williams, Lucy Stone Hall, Livingston Campus (732/445-4030)

Members of the Graduate Faculty

Vilna Bashi Bobb, *Assistant Professor of Sociology, FAS–NB; Ph.D., Wisconsin*
Immigration; race; social networks
József Böröcz, *Associate Professor of Sociology, FAS–NB/Institute for Hungarian Studies; Ph.D., Johns Hopkins*
Historical; comparative; economic; leisure migration; stratification
Ethel C. Brooks, *Assistant Professor of Sociology, FAS–NB; Ph.D., New York*
International political economy; globalization; work and labor markets
Deborah Carr, *Assistant Professor of Sociology, FAS–NB/IHHCPAR; Ph.D., Wisconsin*
Sociology of the life course, social psychology
Karen A. Cerulo, *Professor of Sociology, FAS–NB; Ph.D., Princeton*
Culture; communications; deviance; methods
Lee Clarke, *Associate Professor of Sociology, FAS–NB; Ph.D., SUNY (Stony Brook)*
Organizations; technology and risk
Ira J. Cohen, *Associate Professor of Sociology, FAS–N; Ph.D., Wisconsin*
Social theory; sociology of everyday life
Jeanette Covington, *Associate Professor of Sociology, FAS–NB; Ph.D., Chicago*
Deviance/criminology
Stephen Crystal, *Professor of Social Work, SSW/IHHCPAR; Ph.D., Harvard*
Social policy; social gerontology; AIDS
Nancy DiTomaso, *Professor of Management, RBS; Ph.D., Wisconsin*
Organizations; theory; economy and society
Lucile Duberman, *Associate Professor of Sociology, FAS–N; Ph.D., Case Western Reserve*
Marriage; family
William A. Firestone, *Professor of Educational Theory, Policy, and Administration, GSE; Ph.D., Chicago*
Education; policy implementation; qualitative methods; organizations
Judith J. Friedman, *Associate Professor of Sociology, FAS–NB; Ph.D., Michigan*
Urban communities; environment; demography
Judith M. Gerson, *Associate Professor of Sociology, FAS–NB; Ph.D., Cornell*
Gender; work; social theory

Ted G. Goertzel, *Professor of Sociology, FAS–C; Ph.D., Washington*
Political stratification; social welfare
Sherry Gorelick, *Associate Professor of Sociology, FAS–NB; Ph.D., Columbia*
Education; ethnicity
Stephen Hansell, *Associate Professor of Sociology, FAS–NB/IHHCPAR;*
Ph.D., Chicago
Medical; social psychology; education
Clayton A. Hartjen, *Professor of Sociology, FAS–N; Ph.D., New York*
Criminology and deviant behavior
Paul Hirschfield, *Assistant Professor of Sociology, FAS–NB; Ph.D., Northwestern*
Criminology
Allan V. Horwitz, *Professor of Sociology, FAS–NB/IHHCPAR; Ph.D., Yale*
Deviance and social control; mental illness; law
Ellen L. Idler, *Professor of Sociology, FAS–NB/IHHCPAR; Ph.D., Yale*
Health; aging; religion
John C. Leggett, *Associate Professor of Sociology, FAS–NB; Ph.D., Michigan*
Labor; gender; race; class; survey research; political
Donald Light, *Professor of Sociology and Community Medicine, UMDNJ–SOM;*
Ph.D., Brandeis
Comparative health care; social policy; professions
John L. Martin, *Associate Professor of Sociology, FAS–NB; Ph.D.,*
California (Berkeley)
Culture/belief; religion; numerical analysis of qualitative data
Leslie McCall, *Associate Professor of Sociology, FAS–NB; Ph.D., Wisconsin*
Gender; work and labor markets; theory
Paul McLean, *Assistant Professor of Sociology, FAS–NB; Ph.D., Chicago*
Historical-comparative; economic; patronage networks
David Mechanic, *University Professor and René Dubos Professor of Behavioral*
Sciences, IHHCPAR; Ph.D., Stanford
Medical; social psychology; psychiatry
Ann Mische, *Assistant Professor of Sociology, FAS–NB; Ph.D., New School*
for Social Research
Political culture; social movements; social networks; micro-
interaction; temporality
Ann P. Parelius, *Associate Professor of Sociology, FAS–NB; Ph.D., Chicago*
Education; marriage and family
Robert J. Parelius, *Associate Professor of Sociology, FAS–NB; Ph.D., Chicago*
Education
Julie Phillips, *Assistant Professor of Sociology, FAS–NB/CUPR;*
Ph.D., Pennsylvania
Demography; crime; migration; methods; urban geography; mortality
David Popenoe, *Professor of Sociology, FAS–NB; Ph.D., Pennsylvania*
Family and community; comparative social systems
Patricia A. Roos, *Professor of Sociology, FAS–NB; Ph.D., California (Los Angeles)*
Stratification; work; gender
Sarah Rosenfield, *Associate Professor of Sociology, FAS–NB/IHHCPAR;*
Ph.D., Texas
Medical sociology; mental illness
Thomas Rudel, *Professor of Sociology, CC; Ph.D., Yale*
Development; environment; human ecology
D. Randall Smith, *Associate Professor of Sociology, FAS–NB; Ph.D.,*
Johns Hopkins
Methodology; statistics
Shirley A. Smoyak, *Professor of Urban Studies and Community Health, EJBSPPP;*
Ph.D., Rutgers
Seriously mentally ill adults and children
Arlene J. Stein, *Associate Professor of Sociology, FAS–NB; Ph.D.,*
California (Berkeley)
Gender and sexuality; culture; social movements
Jackson Toby, *Professor of Sociology, FAS–NB; Ph.D., Harvard*
Criminology/deviance; theory; education
Chaim I. Waxman, *Professor of Sociology, FAS–NB; Ph.D., New School*
for Social Research
Religion; ethnicity; social welfare
Helene R. White, *Professor of Sociology, FAS–NB/CAS; Ph.D., Rutgers*
Alcohol and drugs; deviance
Richard Williams, *Associate Professor of Sociology, FAS–NB; Ph.D.,*
SUNY (Binghamton)
Social construction of identities; visual sociology
Robert E. Wood, *Professor of Sociology, FAS–C; Ph.D.,California (Berkeley)*
Political economy of international development
Benjamin D. Zablocki, *Professor of Sociology, FAS–NB; Ph.D., Johns Hopkins*
Methodology; statistics; collective behavior
Eviatar Y. Zerubavel, *Professor of Sociology, FAS–NB; Ph.D., Pennsylvania*
Cognitive sociology; sociology of time; social memory; everyday life

Associate Members of the Graduate Faculty

Drew Humphries, *Associate Professor of Sociology, FAS–C; Ph.D.,*
California (Berkeley)
Criminology; law and society
Valerie R. Johnson, *Associate Professor of Alcohol Studies, CAS; Ph.D., Rutgers*
Alcohol and drug studies

Charles A. Nanry, *Professor of Industrial Relations and Human Resources, SMLR;*
Ph.D., Rutgers
Theory; work and occupations; communications
Karen M. O'Neill, *Assistant Professor of Human Ecology, FAS–NB; Ph.D.,*
California (Los Angeles)
Land-use conflicts; social classes; the state

Adjunct Member of the Graduate Faculty

Carol A. Boyer, *Assistant Research Professor, IHHCPAR; Ph.D., Yale*
Mental health; health care

Programs

The program prepares students for research and for teaching. While it does offer an M.A. degree, the program is designed primarily for students who are seeking a Ph.D. The M.A. degree is seen as a stepping-stone to the Ph.D.

Requirements for the Ph.D. include 21 research credits, a writing seminar worth 3 credits, and 48 credits of approved course work. To meet the course requirement, students may include courses that were taken to satisfy requirements for the M.A. degree. Students may transfer as many as 24 credits from other institutions. Of the 48 credits, 6 must be in theory, 6 in methods, and 6 in statistics.

In addition to course work, students must complete three qualifying papers of publishable quality or submit two such papers and take a qualifying examination in one area of specialization. They also are required to take a writing seminar, defend and win approval of a dissertation proposal, and submit and defend a finished dissertation.

Students generally receive the M.A. degree when they have completed 30 credits of approved course work. Required courses include 3 credits in methods, 3 credits in statistics, and 6 credits in theory. Finally, they must submit one of the qualifying papers for the Ph.D. Upon approval, students may transfer as many as 12 credits earned from other institutions.

Applications for September admission should be submitted no later than February 1 by students seeking financial assistance. In other cases, the deadline is May 1. Official transcripts, a writing sample, and three letters of recommendation are required. The Graduate Record Examination (GRE) also is required, but applicants need not take the advanced test in sociology. Students for whom English is not the first language must take the TOEFL examination if their undergraduate degree was not obtained in the United States.

Graduate Courses

16:920:501,502. SOCIOLOGICAL RESEARCH METHODS I,II (3,3)
Logic, design, and implementation of research to test sociological hypotheses. *First term:* fundamentals of research design, sampling, and measurement. *Second term:* data collection, data management, and exploratory data analysis, including an introduction to computer techniques. Laboratory exercises required.

16:920:503,504. SELECTED SOCIOLOGICAL PROBLEMS (3,3)
Prerequisite: Permission of instructor. For graduate students wishing to pursue advanced work. By arrangement.

16:920:505,506. INDIVIDUAL STUDIES IN SOCIOLOGICAL THEORY (3,3)
Prerequisite: Permission of instructor. For graduate students wishing to pursue advanced work in fields where no advanced courses are provided. By arrangement.

16:920:511,512. PROSEMINAR IN SOCIOLOGY (3,3)
Selected special topics in sociology.

16:920:515. CLASSICAL SOCIOLOGICAL THEORY (3)
Discussion of the major figures who shaped sociological theory from the mid-19th century to the first three decades of the 20th century.

16:920:516. CONTEMPORARY SOCIOLOGICAL THEORY (3)
Survey of the dominant lines of theoretical development in contemporary sociology.

16:920:520. COMPARATIVE AND HISTORICAL METHODS (3)
Philosophical, theoretical, and methodological issues involved
in sociological explanations of the development of social systems
over time.

16:920:521. SOCIOLOGY OF EDUCATION (3)
Analysis of the U.S. educational system and its relation to other
social systems. Major focus on the ideology of the system, the
interrelationship of various occupations, and special problems
of urban schools.

16:920:523. SOCIOLOGY OF HEALTH (3)
Social correlates of health and illness in the United States; major
social roles and organizational structures concerned with health
and medical care.

16:920:524. SOCIOLOGY OF ORGANIZATIONS (3)
Basic survey of the sociology of organizations, with emphasis
on current developments.

**16:920:527. RESEARCH SEMINAR IN POLITICAL SOCIOLOGY
AND DEVELOPMENT (3)**
Major theoretical frameworks of political sociology and develop-
ment, and historical and contemporary debates within these fields.

16:920:528. MARRIAGE AND THE FAMILY (3)
Review of the basic concepts and research in the field of marriage
and the family.

16:920:535. PROFESSIONS (3)
Development and functions of professions in advanced industrial
societies. Alternative theories of professionalism evaluated against
the background of sociological studies of different professions,
such as medicine, law, social work, psychology, education, nursing,
engineering, management and planning, the clergy, and the
artistic professions.

16:920:541-542. ANALYSIS OF SOCIOLOGICAL DATA I,II (3,3)
Prerequisite for 16:920:542: 16:920:541 or permission of instructor.
Application of classical and modern statistical techniques to the
analysis of sociological data. Problems of optimal fitting of tech-
nique to level and quality of data emphasized. *First term:* bivariate
techniques, up to and including the analysis of variance. *Second
term:* multivariate techniques, multiple regression, and the general
linear model. Laboratory exercises required.

16:920:550. PRACTICUM IN TEACHING SOCIOLOGY (3)
Trains sociology graduate students to teach, with a specific
emphasis on clear presentations, logical argument, and day-to-
day pedagogical issues.

16:920:570,571,572,573. SPECIAL TOPICS IN SOCIOLOGY (3,3,3,3)

16:920:602. CULTURE, SYMBOLS, AND SOCIAL INTERACTION (3)
Examines several dimensions of the complex interaction between
the social and cultural spheres. Focuses on the ways in which
norms, gestures, and symbols structure interpersonal encounters;
the symbol systems that make possible large-scale interaction
between social members; the ways in which social structure orders
interactions; and the ways in which technology can mediate
social interactions.

16:920:603. SOCIOLOGY OF RELIGION (3)
Religious belief systems and forms of social organization in historical
and cross-cultural perspective; public religious behavior and private
spiritual practice; old and new religious movements; relationship
between religion and other major social institutions (especially the
political and the economic).

16:920:607. SEMINAR IN ORGANIZATIONS (3)
Development of theories and research models concerned
with organizations.

16:920:611. CRIMINOLOGY AND CORRECTIONS (3)
Theories of criminality and methods of treatment and prevention
within the context of the general analysis of deviance and
social control.

16:920:612. SOCIAL DEVIANCE AND SOCIAL CONTROL (3)
Conditions under which people tend to conform or deviate;
probable consequences of deviance and social control for both
deviants and conformists.

16:920:613. THE SOCIOLOGY OF AGE (3)
Theory of age stratification, age structure of the society, aging
of individuals, and connections between aging and various social
processes and social institutions.

16:920:614. SEMINAR IN RACE AND ETHNIC RELATIONS (3)
Analysis of race and ethnic relations from a comparative perspec-
tive; contemporary theory, issues, and problems.

16:920:615. SEMINAR IN QUALITATIVE RESEARCH METHODS (3)
Discussion and guided practice in the collection and analysis
of qualitative data. Major attention on research designs employing
participant observations and/or in-depth interviewing. Case
studies reviewed; collection and analysis of data from a field
research study.

16:920:616. SEMINAR IN SOCIAL STRATIFICATION (3)
Fundamental features of social stratification in both its structural
and dynamic aspects and in terms of its consequences for society
and for the individual.

16:920:618. SOCIOLOGY OF GENDER (3)
Cross-cultural and historical analysis of gender roles; gender in
modern society; gender roles and social institutions; work, family,
religion, politics, and education. Arange of theoretical and empirical
approaches included.

16:920:627. SOCIOLOGY OF SOCIALIZATION (3)
Study of socialization as a concept and as a process; the socialization
of children and adults; variations in socialization among cultures,
socioeconomic status groups, and types of social groups.

16:920:629. DEVELOPMENT AND UNDERDEVELOPMENT (3)
Interdisciplinary perspectives on processes of development, with
focus on phenomena of class and politics.

16:920:631. SOCIOLOGY OF MENTAL ILLNESS (3)
Study of the epidemiology of psychiatric disorders, help-seeking
processes for mental illness, social responses to the mentally ill,
and social policy issues in the mental health field.

16:920:632. SOCIOLOGY OF WORK (3)
Meaning and organization of work; the division of labor: who does
what and how; interactions among occupations; and the quality of
work life in industrial societies.

16:920:633. SEMINAR IN SOCIAL SCIENCE DATA ANALYSIS (3)
Prerequisite: 16:920:542 or permission of instructor.
Advanced topics in quantitative reduction and analysis of data
generated by research in the various social sciences. Topics chosen
from, but not limited to, loglinear analysis, structural equations
models, panel analysis, network analysis, time-series analysis,
and continuous-time process models. Initial sessions focus on
developing the basics of matrix algebra upon which most of these
techniques rely.

**16:920:640. SOCIOLOGICAL PERSPECTIVES ON FEMINIST
THEORY (3)**
Detailed examination of major feminist theories, with an emphasis
on contemporary feminist thought.

16:920:645. DRUGS AND SOCIETY (3)
Examination of causes and consequences of illegal drug use; how drugs came to be criminalized; the current system of drug prohibition in the United States; and alternatives to prohibition, such as decriminalization and legalization.

16:920:646. (S) COGNITIVE SOCIOLOGY (3)
Social context of thinking, focusing on specific cognitive processes: classifying, framing, symbolizing, time-reckoning, perceiving, attending, remembering, and making sense. Draws on sociology of knowledge, phenomenological sociology, ethnomethodology, sociology of science, symbolic interactionism, semiotics, symbolic anthropology, and linguistics.

16:920:701,702. RESEARCH IN SOCIOLOGY (BA,BA)
Prerequisite: Candidacy for Ph.D. required of all students engaged in Ph.D. dissertation research.

16:920:703. WRITING SEMINAR (3)
Sharpen writing and publishing skills as professional sociologists. Writing and rewriting doctoral qualifying papers and dissertation proposals.

SPANISH 940

Degree Programs Offered: Master of Arts, Master of Arts for Teachers, Doctor of Philosophy
Director of Graduate Program: Professor Dámaris M. Otero-Torres, Carpender House, Douglass Campus (732/932-9323)

Members of the Graduate Faculty

Mary Lee Bretz, *Professor Emerita of Spanish, FAS–NB; Ph.D., Maryland*
Nineteenth- and 20th-century Spanish literature
Frank N. Dauster, *Professor Emeritus of Spanish, FAS–NB; Ph.D., Yale*
Contemporary Spanish-American literature; drama; poetry
Mary S. Gossy, *Associate Professor of Spanish, FAS–NB; Ph.D., Harvard*
Golden-age prose, narrative, feminist theory, reader-response, psychoanalysis
Conrado Guardiola, *Professor Emeritus of Spanish, FAS–NB; Doctor en Filosofía y Letras, Zaragoza*
Medieval Spanish literature
Carl Kirschner, *Professor of Spanish, FAS–NB; Ph.D., Massachusetts*
Spanish linguistics; syntax; semantics; bilingualism in the United States
Jorge Marcone, *Associate Professor of Spanish, FAS–NB; Ph.D., Texas*
Latin American literature and environmentalism; theories of literacy; orality, hypermedia
Susan Martin-Márquez, *Associate Professor of Spanish, FAS–NB; Ph.D., Pennsylvania*
Modern peninsular novel; cinema; cultural studies
Tomás Eloy Martínez, *Professor of Spanish-American Literature, FAS–NB; M.A., Paris Institute*
Contemporary Spanish-American narrative; Latin-American studies; film theory; colonial Spanish-American literature
Gabriela Mora, *Professor Emerita of Spanish, FAS–NB; Ph.D., Smith*
Nineteenth- and 20th-century Spanish-American literature; literary theory
Carlos Raúl Narváez, *Associate Professor of Spanish-American Literature, FAS–NB; Ph.D., Columbia*
Twentieth-century Spanish-American and Caribbean literature; poetry; novel; contemporary literary theory
Dámaris M. Otero-Torres, *Associate Professor of Spanish, FAS–NB; Ph.D., California (San Diego)*
Golden Age literature and culture; gender studies and literary theory
Margaret H. Persin, *Professor of Spanish, FAS–NB; Ph.D., Indiana*
Twentieth-century Hispanic poetry; literary theory
Marcy Schwartz, *Associate Professor of Spanish, FAS–NB; Ph.D., Johns Hopkins*
Twentieth-century Spanish-American literature; urban cultural studies; literary theory
Ben. Sifuentes-Jáuregui, *Associate Professor of Spanish, FAS–NB; Ph.D., Yale*
Twentieth-century Spanish-American literature and cultural studies; gender theory and psychoanalysis; U.S. Latino literature
Thomas M. Stephens, *Professor of Spanish, FAS–NB; Ph.D., Michigan*
Hispanic ethno- and sociolinguistics, lexicography
Phyllis Zatlin, *Professor of Spanish, FAS–NB; Ph.D., Florida*
Contemporary Spanish film and theater/novel; translation studies

Associate Members of the Graduate Faculty

César Braga-Pinto, *Assistant Professor of Portuguese, FAS–NB; Ph.D., California (Berkeley)*
Colonial Brazilian literature
José Camacho, *Assistant Professor of Spanish and Linguistics, FAS–NB; Ph.D., Southern California*
Spanish linguistics (syntax, phonology, semantics, and bilingualism)
Yeon-Soo Kim, *Assistant Professor of Spanish, FAS–NB; Ph.D., Yale*
Contemporary Spanish narratives and films
Phillip Rothwell, *Assistant Professor of Portuguese, FAS–NB; Ph.D., Cambridge*
Interdisciplinary approach to Lusophone cultures; thalassic theory
Liliana Sánchez, *Assistant Professor of Spanish, FAS–NB; Ph.D., Southern California*
Second-language acquisition; bilingualism; Quechua and Spanish syntax
Adolf Snaidas, *Associate Professor of Spanish, FAS–NB; Ph.D., Rutgers*
Spanish-American literature
Camilla Stevens, *Assistant Professor of Spanish, FAS–NB; Ph.D., Kansas*
Twentieth-century Spanish-American theater; Hispanic Caribbean literature; literary and cultural studies; theater theory

Programs

The department offers several options for advanced study. The M.A./Ph.D. option in Spanish prepares students for careers in research and teaching in Hispanic studies. The M.A. option in translation prepares students for careers in commerce, industry, and the judicial system. The M.A.T. program is designed for individuals already teaching Spanish at the secondary or junior college level. Both the M.A. option in translation and the M.A.T. are terminal degrees.

The M.A./Ph.D. program deals primarily with Spanish and Spanish-American literature and culture. It also may include course work in Luso-Brazilian literature and linguistics. This program is open to applicants with distinguished academic records and high GRE scores. Doctoral candidates are expected to complete 54 credits of course work beyond the bachelor's degree, with 12 of those credits in a major field of concentration. Students have the option to declare a minor inside or outside the department. Candidates must pass a written qualifying examination and complete 24 credits of research. They are expected to submit their doctoral thesis proposals when they take their written examinations.

Candidates for the M.A. degree who elect to write a thesis may devote 6 of their required credits to a research problem. In this case, however, they are required to make an oral defense of their thesis. At this time, faculty members screen those M.A. candidates who wish to continue for a doctorate. Exceptional candidates nominated by the faculty have the option to bypass the master's examination and proceed to the 24 credits of required Ph.D. course work.

Credit for graduate work taken at other institutions may be accepted in partial fulfillment of the course requirements. This normally may be no more than the equivalent of one year of course work (24 credits) at Rutgers. Candidates must demonstrate a reading knowledge of two foreign languages chosen from among German, Latin, and the Romance languages other than Spanish. This language requirement must be satisfied before the student is admitted to the qualifying examination.

The doctoral qualifying examination is a written examination based on reading lists covering the student's major and minor fields of concentration and two more general areas of study. Once the student has fulfilled the course and language requirements and passed this qualifying examination, he or she is admitted to candidacy for the Ph.D. and may then proceed with the preparation of the dissertation.

The master of arts option in translation provides advanced training for translators and interpreters who are preparing for careers in legal, commercial, medical, technical, and social service fields. Applicants are admitted on the basis of academic record, GRE general test scores, and a personal statement submitted in English and in Spanish. The 24 credits of course work may include theory and practice of translation and interpretation, linguistics, literature, culture, and literary theory. There is a foreign language requirement and a 6-credit thesis, which is a translation.

The M.A.T. program is designed for individuals already teaching Spanish. Applicants are admitted on the basis of prior academic and/or professional performance. Scores from the GRE are not required for admission. The 30 credits of course work may include language, linguistics, methodology, literature, and culture. Additionally, the graduate program in Spanish participates in the Transliteratures program (q.u.).

Admission

To be admitted to the graduate program in Spanish and the Graduate School–New Brunswick, applicants must meet the following criteria: have a baccalaureate degree from an accredited institution, submit a completed application form, and present a minimum of three letters of recommendation. They also must submit supporting documentation, such as TOEFLscores, GRE scores, and/or a textual analysis. It is recommended that candidates have some life experience or study abroad in a Spanish-speaking environment.

Normally, students who seek entrance to the Spanish graduate programs have an undergraduate degree in Spanish. It is unusual, though not entirely impossible, for undergraduate majors of curricula other than Spanish to seek entrance. At times an individual without the conventional degree in Hispanic studies may seek admission to the graduate program. In such cases, the faculty may require that he or she take undergraduate or graduate courses on a nonmatriculated basis to make up for any deficiencies. The decision on admission is delayed until the student completes this remedial work. If the courses taken on a nonmatriculated basis were on the graduate level, and the student is subsequently accepted for admission to the program, those credits will count toward the graduate degree.

The Graduate School–New Brunswick must approve admission to the graduate program in the Department of Spanish and Portuguese. Normally, the department requires its candidates to have maintained a cumulative grade-point average of 3.0 or better during the junior and senior undergraduate years, and a grade-point average of 3.5 in the major field of study. GRE scores are required for admission to all programs except for the M.A.T. Foreign students also must submit TOEFLscores.

Graduate Courses

Approximately six courses from the following list are offered each term.

16:940:500. METHODS OF SPANISH LANGUAGE TEACHING (K–12) (3)
Ph.D. students do not receive degree credit for this course.
Methods of teaching Spanish to English speakers at the K–12 levels. Theoretical issues, curriculum development, uses of technology, software applications, library resources.

16:940:501. (F) METHODOLOGY OF TEACHING AND RESEARCH (3)
L. Sánchez. Required of Ph.D. students and teaching assistants in Spanish. Ph.D. students do not receive degree credit for this course.
Methods of teaching Spanish to English speakers at the university level. Discussion of issues arising in the classroom. Research in foreign languages: library resources, theoretical issues.

16:940:502. ADVANCED TRANSLATION (3)
Zatlin. Required of all candidates for the M.A. translation option.
Intensive practice in the translation of short texts in various fields from Spanish into English and English into Spanish, with emphasis on technical, legal, and literary translation. Discussion of translation theory and research methods, including use of the Internet.

16:940:503,504. ADVANCED GRAMMARAND STYLISTICS (3,3)
Ph.D. students do not receive degree credits for these courses.
Selected problems of advanced style and grammar, with special emphasis on idiomatic usage, themes, essays, oral presentations.

16:940:505. (F) SPANISH CULTURE AND CIVILIZATION (3)
Ph.D. students do not receive degree credit for this course.
The land and the people of Spain. The national character and its historical and cultural evolution through the present.

16:940:506. (S) CULTURE AND CIVILIZATION IN LATIN AMERICA (3)
Ph.D. students do not receive degree credit for this course.
Emphasis on major sociological, geographical, and cultural factors.

16:940:507,508. THE SPANISH LANGUAGE ACROSS THE CURRICULUM (K–12) (3,3)
Ph.D. students do not receive degree credit for these courses.
Development of content-based K–12 teaching materials with emphasis on humanities, social and natural sciences, and mathematics. Application of national standards in the Spanish-language classroom. Technology and culture components.

16:940:509,510. MAIN CURRENTS OF HISPANIC LITERATURE (3,3)
Ph.D. students do not receive degree credit for these courses.
Critical study of texts exemplifying the principal currents of Hispanic literature from the Middle Ages to the present.

16:940:511. (F) HISTORY OF THE SPANISH LANGUAGE (3)
Stephens
Development of the Spanish language from its origins to the present. Relationship of external history to linguistic development.

16:940:512. THE HISPANIC CHILD IN LITERATURE AND CULTURE (3)
Ph.D. students do not receive degree credit for this course.
Introduction to children's literature in Spanish. Hispanic oral tradition, music, theater, performance, games, storytelling, total physical response applications, multimedia technology, the bilingual child in the classroom. Practical and theoretical issues.

16:940:513,514. MEDIEVAL LITERATURE (3,3)
Major works of medieval literature, including epic poetry, *mester de clerecía,* prose, and lyric poetry.

16:940:517. (F) DRAMA OF THE GOLDEN AGE (3)
Otero-Torres
Development of dramatic literature from its origins through the 17th century.

16:940:520. (F) THE PICARESQUE GENRE IN SPAIN (3)
Gossy
Origins, growth, and decline; such works as *El Lazarillo de Tormes,* Mateo Alemán's *Guzmán de Alfarache, La Pícara Justina,* Quevedo's *El Buscón,* Vincente Espinel's *La Vida de Marcos de Obregón,* Cervantes' *Novelas ejemplares.*

16:940:521. (S) POETRY OF THE GOLDEN AGE (3)
Otero-Torres
The poetical world of the period. Analysis and literary significance of the most representative poets: Garcilaso, Fray Luis de León, Herrera, Lope de Vega, Góngora, and Quevedo.

16:940:522. (S) BALLADRY OF SPAIN (3)
Persin
How Spanish ballads originated, grew, and multiplied over the world. Different themes and styles. Their significance as sources of other literature. Analysis of several "romanceros," including Menéndez Pidal's *Flor nueva de romances viejos.*

16:940:523. (F) DON QUIXOTE (3)
Gossy
Critical study of Cervantes' masterpiece; analysis of its importance within the Golden Age and across the centuries.

16:940:525. (S) NEOCLASSICISM (3)
Major works of the 18th century, including Feijóo, Jovellanos, Moratín, and Cadalso.

16:940:527. (F) ROMANTICISM (3)
Poetry, prose, and theater of the romantic period. Relation of Spanish romanticism to other European literature.

16:940:529. (F) REALISM AND NATURALISM (3)
Spanish literature of the latter part of the 19th century, with emphasis on the novel.

16:940:531. (S) Spanish Modernism (3)
Persin
Study of representative authors from early 20th-century Spain and the problem of such classifications as "Generation of 1898," "Modernismo," and "Novecentismo."

16:940:533. (F) Prose Fictionof the 20th Century (3)
Zatlin
Selected novels and short stories of the pre– and post–Civil War period. The *vanguardistas,* social realism, the new novel.

16:940:535. (S) Spanish Poetry of the 20th Century (3)
Persin
Application of contemporary critical methods to poets of the generation of 1927 and postwar period.

16:940:537. (F) Twentieth-Century Spanish Theater (3)
Zatlin
Benavente, Valle-Inclán, García Lorca, Buero Vallejo, Mihura, the Generación Realista, and the Nuevos Autores. Relationships to the Hispanic tradition and to currents in modern theater.

16:940:539. (S) Spanish Women Writers of the 19thand 20th Centuries (3)
Persin, Zatlin
Application of contemporary feminist criticism to selected poetry, prose, and plays.

16:940:541. (F) Modern Spanish Essay (3)
Study of the essay in Spain through representative writers from the 18th, 19th, and 20th centuries.

16:940:542. Spanish Literature into Film (3)
Zatlin
Spanish novels and plays compared to their film counterparts. Theoretical consideration of narrative strategies of cinema and television in relation to narrative or theatrical techniques of the source texts.

16:940:543. (F) Colonial Spanish-American Literature (3)
Development of new world literature as an independent entity.

16:940:545. (S) Nineteenth-Century Spanish-American Literature (3)
Regionalism, romanticism, and the Wars of Independence; precursors of modernism.

16:940:547. (F) Modernism in Spanish America (3)
Development of modernism, with special emphasis on poetry. Darío, Parnassianism, and symbolism; French influence and the autochthonous contribution. The evolution of modernism toward postmodernism.

16:940:549. (F) Contemporary Spanish-American Poetry (3)
Narváez
Spanish-American poetry as an autonomous linguistic and artistic product incorporating literature in Spanish into modern world literature as part of a general renaissance in culture.

16:940:551,552. Contemporary Spanish-American Novel (3,3)
Marcone, Narváez, Schwartz, Sifuentes
Accepted masterpieces of contemporary writing in Spanish America. Relation of the American novel to the genre in Europe, and Spain in particular.

16:940:553. (S) Contemporary Spanish-American Short Story (3)
Schwartz
Tendencies in the modern short story, with particular emphasis on the postmodern period. Realism and fantasy; the short story as a document and as a social instrument.

16:940:555. (S) Contemporary Spanish-American Theater (3)
Spanish-American theater renaissance in the 20th century. Origins of rural theater in Argentina; experimental theater and revolutionary theater in Mexico. Postwar movements. Particular emphasis on works of Florencio Sánchez, Rodolfo Usigli, and the younger playwrights.

16:940:556. (S) Spanish-American Thought from Pre-Independence through Modernism (3)
Consideration of texts that figure in the Spanish-American debate concerning the Enlightenment, the movement toward independence, and eventual development of Spanish-American modernism.

16:940:557. (S) Twentieth-Century Spanish-American Essay (3)
Consideration of representative essayists of the 20th century; their impact on literary and cultural development of Spanish America.

16:940:562. (S) Approaches to the Teaching of Hispanic Literature (3)
Persin
Current approaches to literature and methods of teaching literature to introductory-level students.

16:940:563. (F) Theory and Practice of Translation (3)
Zatlin. Prerequisite: 16:940:502 or equivalent, or permission of graduate director.
Introduction to translation studies. Application of linguistic and literary theory to translation. Problems of equivalence. Translation quality assessment. Practice in nonliterary and literary translation, including narrative, poetry, and theater.

16:940:579. (F) Translation Workshop (3)
Zatlin. Prerequisite: 16:940:502 or equivalent, or permission of graduate director.
Intensive practice in advanced translation, Spanish to English and English to Spanish. Nonliterary and literary texts. Individual and group projects, with emphasis on translation into the native tongue.

16:940:584. (S) Spanish Syntax (3)
Structuralism, transformational-generative grammar, case grammar, and generative semantics.

16:940:585. (S) Spanish Phonology (3)
Spanish phonetics, phonology, and morphology within the structuralist, generative, and natural generative frameworks.

16:940:586. (S) The Spanish Language in Social Contexts (3)
Stephens
Theoretical issues of dialectology and bilingualism and applications to the Spanish of Spain, Spanish America, and the U.S. Spanish language contact areas throughout the world.

16:940:588,589. Seminar: Topics in Hispanic Linguistics (3,3)
Ph.D. students normally do not receive degree credit for these courses.
Recent developments in applied and theoretical linguistics. Topics include second language acquisition; applied phonetics and syntax; pedagogical implications of linguistics, language contact phenomena, and language variation.

16:940:590. (F) Main Currents in Portuguese Literature (3)
Critical study of texts exemplifying principal currents of Portuguese literature from the Middle Ages to the present.

16:940:591. (S) Topics in Portuguese Literature (3)
Major 16th-century poets and writers, such as Gil Vicente, Luís De Camões, and Bernardím Ribeiro.

16:940:595. (S) Modernism in Brazilian Literature (3)
Critical readings of the major poets and writers, such as Mario de Andrade, Oswald de Andrade, and Manuel Bandeira.

16:940:597,598. (S) Seminar in Hispanic Literature (3,3)
In-depth study of a specific genre, author, or theme in Spanish-language literature. Critical theory, literary analysis, and development of interpretation skills.

16:940:599. Independent Study in Spanish (3)
Staff. Prerequisites: One term of course work. First-term students normally not eligible. Permission of the graduate director and the faculty member directing the study required. Students limited to one independent study course during their degree program.
Intensive study of a specific area of peninsular or Latin American literature or language not covered in regularly scheduled classes.

16:940:612. (S) Seminar: Literary Theory (3)
Gossy, Persin. Required of Ph.D. candidates.
Current critical theory applied to Hispanic texts, starting with Russian formalism and including phenomenological, structuralist, psychoanalytical, sociological-Marxist, reader-response, and deconstructionist, as well as other poststructuralist approaches.

16:940:613. (S) Seminar: Medieval Literature (3)

16:940:617. (F) Seminar: Drama of the Golden Age (3)

16:940:619. (F) Seminar: Novel of the Golden Age (3)

16:940:620. (F) Seminar: Nonfiction of the Golden Age (3)

16:940:621. (F) Seminar: Poetry of the Golden Age (3)

16:940:623. (S) Seminar: Cervantes (3)

16:940:629. (F) Seminar: Realism and Naturalism (3)

16:940:631. (F) Seminar: Generation of 1898 (3)

16:940:633. (S) Seminar: Novel of the 20th Century (3)

16:940:635. (S) Seminar: Poetry of the 20th Century (3)

16:940:637. (S) Seminar: Theater of the 20th Century (3)

16:940:645. (F) Seminar: Nineteenth-Century Spanish-American Literature (3)

16:940:647. (S) Seminar: Modernism in Spanish America (3)

16:940:649. (F) Seminar: Poetry of Spanish America (3)

16:940:651. (S) Seminar: Novel of Spanish America in the 20th Century (3)

16:940:653. (S) Seminar: Short Story of Spanish America in the 20th Century (3)

16:940:655. (F) Seminar: Contemporary Spanish-American Theater (3)

16:940:659,660. Seminar: Advanced Topics in Hispanic Literature (3,3)

16:940:701,702. Research in Spanish (BA,BA)

STATISTICS 960

Degree Programs Offered: **Master of Science, Doctor of Philosophy**
Director of Graduate Program: **Professor Cunhui Zhang, 504 Hill Center for the Mathematical Sciences, Busch Campus (732/445-2693)**
Web Site: *http://www.stat.rutgers.edu*

Members of the Graduate Faculty

Robert H. Berk, *Professor of Statistics, FAS–NB; Ph.D., Harvard*
Sequential methods; nonparametric statistics; quality control and large-sample theory
Javier F. Cabrera, *Associate Professor of Statistics, FAS–NB; Ph.D., Princeton*
Statistical computing and graphics; computer vision; directional data analysis
Arthur Cohen, *Professor of Statistics, FAS–NB; Ph.D., Columbia*
Statistical inference; decision theory; multivariate analysis; and linear models
Ramanathan Gnanadesikan, *Professor Emeritus of Statistics, FAS–NB; Ph.D., North Carolina*
Graphical methods; multivariate analysis; robust procedures
Richard F. Gundy, *Professor of Statistics, FAS–NB; Ph.D., Indiana; Ph.D., Chicago*
Probability theory; harmonic analysis
Donald R. Hoover, *Associate Professor of Statistics, FAS–NB; Ph.D., Stanford*
Longitutional methods; applied statistics and multiple comparisons
Johannes H.B. Kemperman, *Professor Emeritus of Mathematics and Statistics, FAS–NB; Ph.D., Amsterdam*
Probability and statistics; mathematical analysis
John E. Kolassa, *Associate Professor of Statistics, FAS–NB; Ph.D., Chicago*
Asymptotics; biostatistics
Regina Y. Liu, *Professor of Statistics, FAS–NB; Ph.D., Columbia*
Nonparametric inferences; resampling; applications of data depth; statistical quality control
David Madigan, *Professor of Statistics, FAS–NB; Ph.D., Trinity (Dublin)*
Data mining; statistical computing
Joseph I. Naus, *Professor of Statistics, FAS–NB; Ph.D., Harvard*
Applied probability; sampling theory; data quality control; clustering and coinci-dence models; matching in DNA sequences

Douglas A. Penfield, *Professor of Statistics, GSE; Ph.D., California (Berkeley)*
Educational statistics
Harold B. Sackrowitz, *Professor of Statistics, FAS–NB; Ph.D., Columbia*
Inference and decision theory; acceptance sampling; order-restricted inference
Lawrence Shepp, *Professor of Statistics, FAS–NB; Ph.D., Princeton*
Pure and applied probability tomography
Kesar Singh, *Professor of Statistics, FAS–NB; Ph.D., Indian Statistical Institute*
Nonparametric statistics; asymptotics; large deviations; resampling procedures: bootstrap and jackknife; notions of data depth; angular data
William E. Strawderman, *Professor of Statistics, FAS–NB; Ph.D., Rutgers*
Decision theory; Bayesian analysis; multivariate statistics
Henry Teicher, *Professor Emeritus of Statistics, FAS–NB; Ph.D., Columbia*
Probability theory; statistical inference
J. Richard Trout, *Professor Emeritus of Statistics and Computer Science, CC; Ph.D., Rutgers*
Regression analysis; design and analysis of experiments
David E. Tyler, *Professor of Statistics, FAS–NB; Ph.D., Princeton*
Multivariate analysis; robust statistics; directional data; psychometrics; computer vision and time series
Yehuda Vardi, *Chairperson and Professor of Statistics, FAS–NB; Ph.D., Cornell*
Development of general statistical methodologies for real-life problems; image tomography, image restoration and reconstruction and statistics
Minge Xie, *Associate Professor of Statistics, FAS–NB; Ph.D., Illinois*
Longitudinal data analysis; robust statistics; experimental design; biostatistics
Cunhui Zhang, *Professor of Statistics, FAS–NB; Ph.D., Columbia*
Empirical Bayes; survival analysis and incomplete data; statistical inference; probability theory

Associate Members of the Graduate Faculty

Steven Buyske, *Assistant Professor of Statistics, FAS–NB; Ph.D., Rutgers*
Biostatistics, psychometrics, experimental design, tomography
Rebecka Jornsten, *Assistant Professor of Statistics, FAS–NB; Ph.D., California (Berkeley)*
Applied statistics; image and signal processing; time series
Juan K. Lin, *Professor of Statistics, FAS–NB; Ph.D. Chicago*
Multivariate analysis; probabilistic networks; clustering; machine learning
Jeffrey K. Smith, *Professor of Educational Statistics and Measurement, GSE; Ph.D., Chicago*
Educational statistics

Programs

The faculty of statistics offers graduate programs leading to the master of science and doctor of philosophy degrees. The M.S. program emphasizes statistical methods and applications and provides options in biostatistics, quality management and productivity, and data mining. The Ph.D. program offers specializations in applied and theoretical statistics and probability theory. The master of philosophy is available to doctoral candidates.

M.S. candidates must complete 30 course credits, pass a comprehensive examination, and submit an approved essay. The required courses for the M.S. degree include 16:960:563 Regression Analysis; 16:960:582 Introduction to Methods and Theory of Probability; 16:960:583 Methods of Inference; 16:960:586 Interpretation of Data I; and 16:960:590 Design of Experiments. Requirements for the M.S. program may be satisfied in a part-time evening program.

Students may complete the M.S. program with or without one of the following three options. The option in biostatistics requires 16:960:584, 585 Biostatistics I, II; and either 16:960:542 Life Data Analysis or 16:960:553 Categorical Data Analysis, in addition to the general requirements of the M.S. program. The option in quality management and productivity, offered in cooperation with the graduate program in industrial and systems engineering, requires 16:960:540 Statistical Quality Control I; 16:960:542 Life Data Analysis; 16:960:591 Advanced Design of Experiments; 16:540:580 Quality Management; and 16:540:585 Systems Reliability Engineering, in addition to the general requirements of the M.S. program. The option in data mining, offered in cooperation with the graduate program in computer science, requires 16:960:567 Applied Multivariate Analysis; 16:960:587 Interpretation of Data II; 16:960:588 Data Mining; 16:198:513 Design and Analysis of Data Structures and Algorithms; and 16:198:536 Machine Learning, and waives the requirement of 16:960:590

The Ph.D. program requires 48 course credits and a dissertation. Research work follows successful completion of qualifying examinations. The first of these examinations is taken near the end of the first year of study after completion of 16:960:592 Theory of Probability; 16:960:593 Theory of Statistics; and 16:960:680

Advanced Probability Theory I. The second examination is generally taken in the second or third year of study after completion of 16:960:652, 653 Advanced Theory of Statistics I, II; 16:960:663 Regression Theory; and 16:960:681 Advanced Probability Theory II. In addition to these seven core courses for the qualifying examinations, the Ph.D. program requires 16:960:587 Interpretation of Data II; two more 3-credit courses in statistics at the 600 level; 24 research credits; and three terms of 16:960:693 Current Topics in Statistics.

All Ph.D. candidates are required to demonstrate proficiency in one foreign language related to their chosen fields or in computer programming relevant to statistics. While there is no formal residency requirement, the faculty urges Ph.D. candidates to spend at least one full academic year in residence.

An entering Ph.D. student should have a good background in mathematics, including advanced calculus and linear algebra. These latter subjects, however, are not required to gain admission. Each student selects his or her program in conference with a department adviser. There is a wide range of course offerings and areas of research. These include statistical inference, estimation theory, operations research, hypothesis testing, decision theory, biostatistics, empirical Bayes and Bayes methods, regression analysis, analysis of variance, experimental design, multivariate analysis, nonparametric statistics, data mining, image and signal processing, statistical computing, sampling theory, robust statistics, survival analysis and incomplete data, longitudinal data, sequential analysis, quality-control theory, time-series analysis, applied probability, stochastic processes, and probability theory, including stopping rules and martingales. Information about recommended course sequences for degrees is available upon request from the office of the graduate director. See also Operations Research in this chapter.

Further information may be found on the web at *http://www.stat.rutgers.edu/curriculum/gradcurr.html.*

Graduate Courses

In the following course list, the Level V statistics prerequisite for some courses may be fulfilled by 16:960:563 or 586 or 593, while the Level IV Statistics prerequisite may be fulfilled by 01:960:401 or 01:960:484 or 16:960:590 or Level V statistics.

16:960:501. (F) STATISTICAL THEORY FOR RESEARCH WORKERS I (3)
Not open to graduate students in statistics.
Designed to strengthen the statistical backgrounds of research workers. Concepts of randomness and probability; frequency distributions; expectations, derived distributions, and sampling; estimation and significance testing.

16:960:502. (S) STATISTICAL THEORY FOR RESEARCH WORKERS II (3)
Prerequisite: 16:960:501 or 511. Not open to graduate students in statistics.
Continuation of 16:960:501. Principles and practices of experimental design as applied to mathematical models; the analysis of variance; factorial designs; analysis of matched groups and repeated measurements on the same group; analysis of qualitative data.

16:960:511. (F) STATISTICAL METHODS IN SOCIAL WORK (3)
For students in the School of Social Work.
Introduction to descriptive and inferential statistics. Frequency distributions and cross-classification techniques; analyzing qualitative and quantitative data; measures of central tendency and dispersion; measures of association, correlation, and regression; probability modeling, sampling distribution, confidence intervals, hypothesis tests.

16:960:531,532. STATISTICAL METHODS IN EDUCATION (3,3)
Penfield. For students in the Graduate School of Education.
First term: graphing, descriptive measures of central tendency and variability, introduction to correlation and regression, probability theory, the normal curve, sampling, point estimation, interval estimation, and elementary hypothesis testing. *Second term:* principles and practices of experimental design; z-test, t-test, chi-square tests, F-test, and analysis of variance.

16:960:540. (F) STATISTICAL QUALITY CONTROL I (3)
Prerequisites: Level IV statistics, 16:960:582 or equivalent.
Construction and analysis of control charts for variables and attributes; histogram analysis; use and evaluation of Dodge-Romig and Military Standards acceptance sampling plans.

16:960:541. (S) STATISTICAL QUALITY CONTROL II (3)
Prerequisites: 16:960:540, 590.
Introduction to state-of-the-art methods in statistical quality control, including economic design and Bayesian methods in process control, Taguchi's method and statistical tolerance.

16:960:542. (S) LIFE DATA ANALYSIS (3)
Prerequisites: One year of calculus, Level V statistics, or permission of instructor.
Statistical methodology for survival and reliability data. Topics include life-table techniques; competing risk analysis; parametric and nonparametric inferences of lifetime distributions; regressions and censored data; Poisson and renewal processes; multistate survival models and goodness-of-fit test. Statistical software used.

16:960:545. STATISTICAL PRACTICE (3)
Prerequisite: Level IV statistics.
Objectives of statistical collaboration, problem definition, formation of solutions, active consultation, tools of statistical practice, searching literature, data collection form design, codebook development, data entry and cleaning, documentation and presentation of statistical analysis.

16:960:553. (F) CATEGORICAL DATA ANALYSIS (3)
Prerequisite: Level V statistics or permission of instructor.
Two-by-two frequency tables, Fisher's exact test, measures of association, general contingency tables, loglinear models, logistic regression, repeated categorical-response data, maximum likelihood estimation, tables with ordered categories, discriminant analysis.

16:960:554. (S) APPLIED STOCHASTIC PROCESSES (3)
Prerequisites: Advanced calculus, 16:960:582 or equivalent.
Markov chains; recurrence; random walk; gambler's ruin; ergodic theorem and stationary distribution; continuous time Markov chains; queuing problems; renewal processes; martingales; Markov processes; Brownian motion; concepts in stochastic calculus; Ito's formula.

16:960:555. (F) NONPARAMETRIC STATISTICS (3)
Prerequisites: Level IV statistics, 16:960:582 or permission of instructor.
Introduction and survey of distribution-free approaches to statistical inference. Fisher's method of randomization, distribution-free test procedures for means, variances, correlations, and trends; rank tests; relative efficiency, asymptotic relative efficiency, and normal-score procedures; binomial, hypergeometric distributions, and combinatorial run theory. Also, tests of goodness-of-fit, including the Kolmogorov-Smirnov and chi-square tests, contingency-table analysis, tolerance sets, and Tchebycheffe-type inequalities. Emphasis on applications.

16:960:563. REGRESSION ANALYSIS (3)
Prerequisite: Level IV statistics.
Review of basic statistical theory and matrix algebra; general regression models, computer application to regression techniques, residual analysis, selection of regression models, response-surface methodology, nonlinear regression models, experimental-design models, analysis of covariance. Emphasis on applications.

16:960:565. (F) APPLIED TIME SERIES ANALYSIS (3)
Prerequisite: Level V statistics or permission of instructor.
Model-based forecasting methods, autoregressive and moving average models, ARIMA, ARMAX, ARCH, state-space models, estimation, forecasting and model validation, missing data, irregularly spaced time series, parametric and nonparametric bootstrap methods for time series, multiresolution analysis of spatial and time series signals, time-varying models and wavelets.

16:960:567. (S) APPLIED MULTIVARIATE ANALYSIS (3)
Prerequisite: Level V statistics or permission of instructor.
Methods of reduction of dimensionality, including principal components, factor analysis, and multidimensional scaling; correlation techniques, including partial, multiple, and canonical correlation; classification and clustering methods. Emphasis on data-analytic issues, concepts, and methods (e.g., graphical techniques) and on applications drawn from several areas, including behavioral management and physical and engineering sciences.

16:960:575. (F) ACCEPTANCE SAMPLING THEORY (3)
Prerequisite: Level IV statistics.
Selection, operation, and statistical behavior of sampling plans. Dodge-Romig plans; continuous, chain, and skip-lot plans; variable sampling plans. Economic analysis and study of sampling systems.

16:960:576. (S) SURVEY SAMPLING (3)
Prerequisite: 16:960:582 or equivalent.
Introduction to the design, analysis, and interpretation of sample surveys. Sampling types covered include simple random, stratified random, systematical, cluster, and multistage. Methods of estimation described to estimate means, totals, ratios, and proportions. Development of sampling designs combining a variety of types of sampling and methods of estimation, and detailed description of sample size determinations to achieve goals of desired precision at least cost.

16:960:580. (S) BASIC PROBABILITY (3)
Prerequisite: One year of calculus. Credit given for only one of 16:960:580, 582, 592.
Discrete-probability spaces, combinatorial analysis, occupancy and matching problems, basic distributions, probabilities in a continuum; random variables, expectations, distribution functions, conditional probability and independence; coin tossing, weak law of large number, deMoivre-Laplace theorem.

16:960:582. (F) INTRODUCTION TO METHODS AND THEORY OF PROBABILITY (3)
Prerequisite: One year of calculus. Credit given for only one of 16:960:580, 582, 592.
Emphasis on methods and problem solving. Topics include probability spaces, basic distributions, random variables, expectations, distribution functions, conditional probability and independence, sampling distributions.

16:960:583. (S) METHODS OF INFERENCE (3)
Prerequisite: 16:960:582. Credit not given for both this course and 16:960:593.
Theory of point and interval estimation and hypothesis testing. Topics include sufficiency, unbiasedness, and power functions. Emphasis on application of the theory in the development of statistical procedures.

16:960:584. (F) BIOSTATISTICS I (3)
Prerequisites: One year of calculus, Level IV statistics.
Statistical techniques for biomedical data. Analysis of observational studies emphasized. Topics include measures of disease frequency and association; inferences for dichotomous and grouped case-control data; logistic regression for identification of risk factors; Poisson models for grouped data; Cox model for continuous data; life table analysis; and SAS used in analysis of data.

16:960:585. (S) BIOSTATISTICS II (3)
Prerequisite: Level IV statistics.
Statistical techniques used in design and analysis of controlled clinical experiments. Topics include introduction to four phases of clinical trials; randomization, blocking, stratification, balancing, power, and sample-size calculation; data monitoring and interim analyses; baseline covariate adjustment; crossover trials; brief introduction to categorical and event-time data; and SAS used in analysis of data.

16:960:586. INTERPRETATION OF DATA I (3)
Prerequisite: Level IV statistics. Recommended: 16:960:563.
Modern methods of data analysis with an emphasis on statistical computing: univariate statistics, data visualization, linear models, generalized linear models (GLM), multivariate analysis and clustering methods, tree-based methods, and robust statistics. Expect to use statistical software packages, such as SAS (or SPSS) and Splus (or R) in data analysis.

16:960:587. (S) INTERPRETATION OF DATA II (3)
Prerequisite: 16:960:586 or permission of instructor.
Modern methods of data analysis and advanced statistical computing techniques: smooth regression (including GAM models), nonlinear models, Monte-Carlo simulation methods, the EM algorithm, MCMC methods, spatial statistics, longitudinal data analysis/mixed effects models/GEE, latent variable models, hidden Markov models, Bayesian methods, etc. Expect to use the statistical software package Splus (or R) and to do some Splus (or R) programming for data analysis.

16:960:588. (F) DATA MINING (3)
Prerequisite: 16:960:567, 587, or permission of instructor.
Databases and data warehousing, exploratory data analysis and visualization, an overview of data mining algorithms, modeling for data mining, descriptive modeling, predictive modeling, pattern and rule discovery, text mining, Bayesian data mining, observational studies.

16:960:590. DESIGN OF EXPERIMENTS (3)
Prerequisite: 01:960:484 or 401 or equivalent.
Fundamental principles of experimental design; completely randomized variance component designs, randomized blocks, Latin squares, incomplete blocks, partially hierarchic mixed-model experiments, factorial experiments, fractional factorials, response surface exploration.

16:960:591. (F) ADVANCED DESIGN OF EXPERIMENTS (3)
Prerequisite: 16:960:590. Recommended: 16:960:563.
Strategy of experimentation, screening designs, factorial designs, response surface methodology, evolutionary operation, mixture designs, incomplete blocking designs, computer-aided experimental designs, and design optimality criteria.

16:960:592. (F) THEORY OF PROBABILITY (3)
Prerequisite: Advanced calculus or permission of instructor. Credit given for only one of 16:960:580, 582, 592.
Emphasis on proofs and fundamental concepts. Topics include probability spaces, basic distributions, random variables, expectations, distribution functions, conditional probability and independence, and sampling distributions.

16:960:593. (S) THEORY OF STATISTICS (3)
Prerequisite: 16:960:592 or permission of instructor. Credit not given for both 16:960:583 and this course.
Theory of point and interval estimation and hypothesis testing. Topics include sufficiency, unbiasedness, Bayes methods, and power functions. Emphasis on fundamental concepts underlying the theory.

16:960:595. INTERMEDIATE PROBABILITY (3)
Prerequisites: Advanced calculus, 16:960:592 or equivalent.
Central limit theorem. Borel-Cantelli lemma, strong law of large numbers; convolutions, generating functions, recurrent events, random walks on line, plane and 3-space, ruin of a gambler, simple time-dependent processes and/or Markov chains.

16:960:652. (F) ADVANCED THEORY OF STATISTICS I (3)
Prerequisites: 16:960:593, real variables.
Theories of statistical inference and their relation to statistical methods. Sufficiency, invariance, unbiasedness, decision theory. Bayesian procedures, likelihood procedures.

16:960:653. (S) ADVANCED THEORY OF STATISTICS II (3)
Prerequisite: 16:960:652.
Hypothesis testing, point and confidence estimation robustness, sequential procedures.

16:960:654. (F) STOCHASTIC PROCESSES (3)
Prerequisite: 16:960:554 or 680 or permission of instructor. Offered in alternate years.
Selected topics from the theory of the Markov processes, queuing theory, birth and death processes, martingale theory, and Brownian motion and related topics. Measure-theoretic notations, as well as ideas from classical analysis used as needed.

16:960:655. (S) ADVANCED NONPARAMETRIC STATISTICS (3)
Prerequisites: 16:960:593, 680, or permission of instructor.
Rank-testing and estimation procedures for the one- and two-sample problems; locally most powerful rank tests. Criteria for unbiasedness; permutation tests. Exact and asymptotic distribution theory; asymptotic efficiency. Rank correlation; sequential procedures; the Kolmogorov-Smirnov test. Emphasis on theory.

16:960:663. (F) REGRESSION THEORY (3)
Prerequisites: 16:960:593, vector spaces and matrices.
Least-squares methods of testing and estimation in multiple regression; geometric interpretation of least-squares; Gauss-Markov theorem. Confidence, prediction, and tolerance intervals in regression. Orthogonal polynomials; harmonic regression. Weighted least-squares. Analysis of variance; simultaneous inference procedures (multiple comparisons). Emphasis on theory.

16:960:664. (S) ADVANCED TOPICS IN REGRESSION AND ANOVA (3)
Prerequisite: 16:960:663.
Development of linear classification models; general results of components of variance for balanced designs; polynomial regression models (response surfaces); crossed models for combined qualitative and quantitative factors; reduced regression models; nonlinear regression computational and statistical procedures.

16:960:667. (S) MULTIVARIATE STATISTICS (3)
Prerequisites: 16:960:593, vector spaces and matrices, or permission of instructor. Offered in alternate years.
Multivariate, marginal, and conditional distributions. Multivariate normal; characterizations and parameter estimation. Wishart distribution; Hotelling's T2 statistic; multivariate linear model; principal component analysis correlations. Multivariate classification; matrices and discriminate methods. Emphasis on theory.

16:960:680. (S) ADVANCED PROBABILITY THEORY I (3)
Prerequisite: Real variables or equivalent.
Measures, measurable functions, integration, limit theorems, Lebesgue measure, Riemann integral, Lebesgue-Stieltjes integral, measure extension, probability measures, random variables, expectation, distribution, independence, Borel-Cantelli lemma, zero-one law, convergence in distribution, convergence in probability, almost sure convergence, law of large numbers, Jensen, Holder, and Minkowski inequalities, convergence in mean, uniform integrability, spaces of functions.

16:960:681. (F) ADVANCED PROBABILITY THEORY II (3)
Prerequisite: 16:960:680 or equivalent.
Characteristic functions, the Lindeberg central limit theorem, Helly's selection theorem, convergence of multivariate distribution functions, conditional probability, the Radon-Nikodym theorem, conditional expectation, martingales, the optional stopping theorem, Doob's inequalities, martingale convergence theorems, random walk, Markov chains, recurrence and transience, stationary measure, convergence theorems for Markov chains, product measures, Fubini's theorem, Kolmogorov consistency theorem, weak convergence of stochastic processes, Brownian motion, the law of the iterated logarithm.

16:960:682,683. INDIVIDUAL STUDIES IN STATISTICS (3,3)

16:960:687,688. SEMINAR IN APPLIED AND MATHEMATICAL STATISTICS (3,3)
Prerequisite: Permission of instructor.
Measure, outer measures, and extensions. Measurable functions. Integration on a measure space. Legesgue and Radon-Nikodym theorems, Hahn and Jordan decompositions. Product spaces and Fubini's theorem. Riesz representation theorem Ip spaces. Conditional probability. Topological and especially metric spaces, Euclidean spaces, Banach spaces. Differentiation, Hilbert spaces.

16:960:689. (F) SEQUENTIAL METHODS (3)
Prerequisites: 16:960:593, 680.
Sequential probability ratio test; approximations for the stopping boundaries, power curve, and expected stopping time; termination with probability one, existence of moments for the stopping time; Wald's lemmas and fundamental identity; Bayes character and optimality of the SPRT. Composite hypotheses: weight-function and invariant SPRTs. Sequential estimation, including fixed-width confidence intervals and confidence sequences.

16:960:690,691. SPECIAL TOPICS (3,3)
Prerequisite: Permission of instructor.
Topics, which change on a rotating basis, include large sample theory, time series analysis, Bayesian statistics, robustness, and sequential analysis.

16:960:693. CURRENT TOPICS IN STATISTICS (1)
Prerequisite: Permission of program director.
Topics change based on statistical research and applications of faculty in and outside department.

16:960:701,702. RESEARCH IN STATISTICS (BA,BA)

THEATER ARTS

(See the catalog of the Mason Gross School of the Arts for information about programs that lead to the master of fine arts in acting, directing, playwriting, design [scenic, costume, and lighting], stage management, and costume technology.)

TOXICOLOGY 963

Members of the Graduate Faculty

Tamar Barkay, *Assistant Professor of Biochemistry, CC; Ph.D., Maryland*
Mercury and bioindicator organisms
Ira Black, *Professor of Neuroscience and Cell Biology, UMDNJ–RWJMS; M.D., Harvard*
Neural stem cell biology
Joanna Burger, *Professor of Biology, FAS–NB; Ph.D., Minnesota*
Heavy metal dynamics in estuarine ecosystems
Suzie Chen, *Associate Professor of Chemical Biology, EMSP; Ph.D., Albert Einstein*
Molecular mechanisms of cell growth and differentiation
John L. Colaizzi, *Professor of Pharmacy and Dean of the Ernest Mario School of Pharmacy, EMSP; Ph.D., Purdue*
Pharmacokinetics
Allan H. Conney, *New Jersey Professor of Pharmacology, EMSP; Ph.D., Wisconsin*
Experimental therapeutics and drug metabolism

Keith R. Cooper, *Professor of Microbiology, CC; Ph.D., Rhode Island*
Xenobiotic metabolism in aquatic animals; animal models

David T. Denhardt, *Professor of Molecular and Cellular Biology, FAS–NB; Ph.D., California Institute of Technology*
Mechanisms of mammalian cell signaling and regulation of gene expression

Emanuel M. DiCicco-Bloom, *Associate Professor of Neuroscience and Cell Biology/Pediatrics, UMDNJ–RWJMS; M.D., Cornell*
Pediatric neurology; neurogenesis

John L. Falk, *Professor of Psychology, FAS–NB; Ph.D., Illinois*
Behavioral mechanisms and drugs of abuse; animal models of alcoholism

Michael A. Gallo, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Albany Medical College*
Food additives; phototoxins; dermatotoxicology; dioxin; molecular biology of estrogen receptors

Donald R. Gerecke, *Assistant Professor of Pharmacology and Toxicology, EMSP; Ph.D., Harvard*
Molecular biology of the extracellular matrix in skin

Michael Gochfeld, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., CUNY (Queens); M.D., Albert Einstein*
Environmental toxicology; behavioral development and occupational medicine

Marion K. Gordon, *Research Associate Professor of Pharmacology and Toxicology, EMSP; Ph.D., Rutgers/UMDNJ–RWJMS*
Gene expression of extracellular matrix molecules during development

William N. Hait, *Professor of Medicine and Pharmacology, UMDNJ–RWJMS; M.D., Ph.D., Medical College of Pennsylvania*
Cancer research and multidrug resistance

Diane E. Heck, *Assistant Research Professor of Pharmacology and Toxicology, EMSP; Ph.D., Rutgers*
Biology of nitric oxide

Jun-Yan Hong, *Associate Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., UMDNJ*
Biochemistry

Michael M. Iba, *Associate Professor of Toxicology, EMSP; Ph.D., Illinois*
Metabolic and molecular basis of arylamine carcinogenesis; developmental toxicology

Sungchul Ji, *Associate Professor of Pharmacy, EMSP; Ph.D., SUNY (Albany)*
Mechanisms of liver injury; noninvasive biophysical probes

Stanley E. Katz, *Professor of Microbiology, CC; Ph.D., Rutgers*
Agricultural microbiology; pesticides; food additives

Frederick C. Kauffman, *Professor of Pharmacology, EMSP; Ph.D., Illinois*
Influence of intermediary metabolism on xenobiotic metabolism; neurotoxicology

Howard Kipen, *Associate Professor of Environmental and Community Medicine, UMDNJ–RWJMS; M.D., California (San Francisco)*
Occupational health

Ah-Ng Tony Kong, *Professor of Pharmaceutics, EMSP; SUNY (Buffalo)*
Pharmaceutics, pharmacokinetics, and drug metabolism

Samuel Kuna, *Visiting Professor of Toxicology, EMSP; Ph.D., New York*
Analgesics

George H. Lambert, *Associate Professor of Pediatrics, UMDNJ–RWJMS; M.D., Illinois*
Pediatric and reproductive environmental health

Debra L. Laskin, *Chairperson and Professor of Toxicology, EMSP; Ph.D., Medical College of Virginia*
Immunology; immunotoxicology; monoclonal antibodies; flow cytometry

Jeffrey D. Laskin, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., SUNY (Buffalo)*
Carcinogenesis and differentiation in cell culture

Edmond J. LaVoie, *Professor of Medicinal Chemistry, EMSP; Ph.D., SUNY (Buffalo)*
Metabolism and structure-activity studies of pharmacological agents

Paul J. Lioy, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., Rutgers*
Air pollution exposure, measurement, and assessment

Herbert E. Lowndes, *Professor of Pharmacology and Toxicology, EMSP; Ph.D., Cornell*
Neurotoxicology

Larissa A. Pohorecky, *Professor of Neuropharmacology, CAS; Ph.D., Chicago*
Alcohol and psychological stress on brain monoamines and behavior

Ronald D. Poretz, *Professor of Biochemistry, CC; Ph.D., SUNY (Buffalo)*
Inherited susceptibility to neurotoxicants; drug delivery; cancer prevention and therapy

Kenneth R. Reuhl, *Professor of Pharmacology and Toxicology, EMSP; Ph.D., Wisconsin*
Developmental neuropathology and neurotoxicology

David J. Riley, *Professor of Medicine, UMDNJ–RWJMS; M.D., Maryland*
Respiratory physiology; respiratory toxicology, effects of oxidants on tissue metabolism and molecular biology

Mark Robson, *Associate Professor of Environmental and Occupational Health, UMDNJ–SPH; Ph.D., Rutgers*
Public health; agrochemical toxicology

Joseph D. Rosen, *Professor of Food Science, CC; Ph.D., Rutgers*
Mutagenesis; mycotoxins

Eric Rubin, *Associate Professor of Medicine, UMDNJ–RWJMS; M.D., Tulane*
Cancer therapeutics; drug transporters

Karen M. Schaich, *Associate Professor of Food Science, CC; Sc.D., Massachusetts Institute of Technology*
EPR studies of free radicals; lipid oxidation; co-oxidation of macromolecules

Robert Snyder, *Professor of Pharmacology and Toxicology, EMSP; Ph.D., SUNY Upstate Medical Center (Syracuse)*
Benzene; bone marrow disease; drug metabolism; carcinogenesis

Patricia K. Sonsalla, *Associate Professor of Neurology, Psychiatry, and Pharmacology, UMDNJ–RWJMS; Ph.D., Utah*
Neurotoxicology, monoamines, and CNS function

Kevin S. Sweder, *Assistant Professor of Chemical Biology, EMSP; Ph.D., California Institute of Technology*
DNA repair and replication of damage-containing DNA directly related to bio-chemical mechanisms of carcinogenesis

Paul E. Thomas, *Professor of Chemical Biology and Pharmacognosy, EMSP; Ph.D., Ohio State*
Antibody probes of the regulation and membrane topology of cytochrome P-450

Thresia Thomas, *Associate Professor of Molecular Genetics, UMDNJ–RWJMS; Ph.D., Indian Institute of Science*
Hormones and breast cancer; cyclins; polyamines

Jay A. Tischfield, *Professor of Genetics, FAS–NB; Ph.D., Yale*
Genetics

George Wagner, *Professor of Psychology, FAS–NB; Ph.D., Chicago*
Neural and behavioral toxicology

Judith Weis, *Professor of Zoology, FAS–NB; Ph.D., New York*
Environmental factors; pollutants; estuarine organisms

Lori White, *Assistant Professor of Biochemistry and Microbiology, CC; Ph.D., Dartmouth Medical School, Wisconsin (Madison)*
Biochemistry and environmental toxicology

Gisela Witz, *Professor of Environmental and Community Medicine, UMDNJ–RWJMS; Ph.D., New York*
Benzene metabolism, tumor promotion, oxygen radical toxicity

Chung S. Yang, *Professor of Pharmacognosy, EMSP; Ph.D., Cornell*
Nitrosamines, carcinogenesis, molecular biology of cytochrome P-450

Renping Zhou, *Associate Professor of Chemical Biology, EMSP; Ph.D., California (Berkeley)*
Development of the brain: function of growth factors and their receptors

Associate Members of the Graduate Faculty

Carol R. Gardner, *Research Associate Professor of Pharmacology and Toxicology, EMSP; Ph.D., Texas Woman's*
Immunotoxicology; immunology; radiation biology

Peter C. Kahn, *Associate Professor of Biochemistry, FAS–NB; Ph.D., Columbia*
Carcinogens; Agent Orange

Gail Zeevalk, *Assistant Professor of Neurology, UMDNJ–RWJMS; Ph.D., CUNY*
Mitochondrial toxins; energy metabolism; glutamate receptors; excitotoxicity ischemia

Programs

The graduate program in toxicology is a cooperative effort between the Graduate School–New Brunswick and the Graduate School of Biomedical Sciences of the University of Medicine and Dentistry of New Jersey. Faculty members from both universities participate in the curriculum.

Students seeking the master of science degree must take a minimum of 29 course credits and submit a thesis based on a minimum of 6 research credits. Students are allowed to pursue an M.S. in toxicology on a part-time basis.

The program leading to a doctor of philosophy in toxicology offers a general curriculum in the first year. After that, students specialize in such tracks as biochemical toxicology, carcinogenesis and molecular biology, neurotoxicology and developmental toxicology, environmental toxicology, and cell and immunotoxicology. The degree requires a minimum of 72 credits, with at least 35 of these credits taken in course work. A minimum of 24 credits is devoted to research. The program features a weekly invited speaker lecture series highlighted by the Annual Morton J. Rodman Distinguished Lectureship in Pharmacology, the Samuel Kuna Distinguished Lectureship in Toxicology, and the Scala Lectureship. The latter features advances in basic research by an industrial toxicologist. Doctoral students are required to complete at least two consecutive terms as full-time resident students.

Requirements for admission include the Graduate Record Examination general test, subject test scores for biology or chemistry, and completed course work in physical chemistry, organic chemistry, physics, biology, and calculus. Additional requirements may be imposed, depending upon the applicant's background.

Graduate Courses

16:963:501,502. General Toxicology I,II (2,2)
Reuhl. Prerequisites: 16:115:503,504, 16:761:501,502, or equivalent.
Basic principles of toxicology, organ toxicology, toxicology of specific chemical agents and radiation, and overview of environmental and industrial toxicology and safety evaluation.

16:963:504. (S) General Toxicology Laboratory (2)
Kauffman. Prerequisite: 16:963:501. Corequisite: 16:963:502.
Introduction to the basic laboratory activities in toxicology. Emphasis on state-of-the-art techniques for toxicity evaluation of chemicals.

16:963:505. (F) Biochemical Toxicology (4)
Iba, Thomas. Prerequisites: 16:115:503,504, permission of instructor.
Metabolism and electrophilic reactions of subsequent toxic metabolites studied with emphasis on kinetics, mutagenesis, carcinogenesis, and organ toxicity.

16:963:601,602. Seminar in Toxicology (1,1)
Students present reports on current topics in toxicology; during the first two years, a minimum of two reports a year required, and thereafter, one per year.

16:963:603. Advanced Problems in Toxicology (BA)
Prerequisites: Permission of adviser and graduate director.

16:963:605,606. Advanced General Pharmacology I,II (4,4)

16:963:631. Toxicological Pathology (3)
Reuhl
Stresses morphological effects of chemical agents in cells and organs. Includes chemical and pathological correlates in laboratory animal models.

16:963:632. (S) Neural Injury and Repair (3)
Lowndes, Sonsalla
Mechanisms by which the nervous system is damaged by chemicals, trauma, and other agents. Neurobiological basis for its response to injury.

16:963:633. (S) Molecular Toxicology (2)
Hong, Zhou
Laboratory techniques used in toxicological research. Students will analyze research data and evaluate the techniques used.

16:963:701,702. Research in Toxicology (BA,BA)

Related Graduate Courses

16:115:556. Ethical Scientific Conduct (1)

16:215:555. Ecology and Ecological Risk (3)

16:718:780. Cellular and Molecular Pharmacology: Principles of Drug Action and Targeting (3)

16:761:501,502. Mammalian Physiology (3,3) (BA)

URBAN PLANNING AND POLICY DEVELOPMENT 970

Degree Program Offered: **Doctor of Philosophy**
Director of Graduate Program: **Professor David Listokin,**
Edward J. Bloustein School of Planning and Public Policy (EJBSPPP), 33 Livingston Avenue (732/932-3822)
Web Site: *http://www.policy.rutgers.edu*

Members of the Graduate Faculty

Hooshang Amirahmadi, *Professor of Urban Planning, EJBSPPP; Ph.D., Cornell*
Third world development (regional/national); global economic restructuring
Clinton J. Andrews, *Assistant Professor of Urban Planning, EJBSPPP; Ph.D., Massachusetts Institute of Technology*
Energy and environmental planning; regulatory reform; planning methods

Glenn Beamer, *Assistant Professor of Planning and Public Policy, EJBSPPP; Ph.D., Michigan*
Institutional politics; political economy; methodology, welfare reform
Richard K. Brail, *Professor of Urban Planning, EJBSPPP; Ph.D., North Carolina*
Transportation; computer applications; quantitative analysis
Robert W. Burchell, *Professor, CUPR; Ph.D., Rutgers*
Empirical analysis in housing; land use; municipal finance
Joel Cantor, *Professor of Public Policy, EJBSPPP; Director, Center for State Health Policy; Sc.D., Johns Hopkins*
Health care financing and delivery; health care policy
Robert A. Catlin, *Professor of Public Policy, EJBSPPP; Ph.D., Illinois Institute of Technology*
Planning history and theory; housing and community development
Henry A. Coleman, *Professor of Public Policy, EJBSPPP; Director, Center for Government Services; Ph.D., Princeton*
Public policy; state and local finances
Jocelyn Elise Crowley, *Assistant Professor of Public Policy, EJBSPPP; Ph.D., Massachusetts Institute of Technology*
Social policy; American politics
Salah El-Shakhs, *Professor of Urban Planning, EJBSPPP; Ph.D., Harvard*
Comparative urbanization and urban development
Bari Anhalt Erlichson, *Assistant Professor of Public Policy, EJBSPPP; Ph.D., Stanford*
Education policy and politics
Norman J. Glickman, *State of New Jersey Professor of Urban Planning, EJBSPPP; Ph.D., Pennsylvania*
Urban and regional economics and policy
Judith Grant-Long, *Assistant Professor of Urban Planning, EJBSPPP; Ph.D., Harvard*
Urban redevelopments
Michael R. Greenberg, *Associate Dean and Professor of Urban Studies and Community Health, EJBSPPP; Ph.D., Columbia*
Environmental planning; public health
David H. Guston, *Associate Professor of Public Policy, EJBSPPP; Ph.D., Massachusetts Institute of Technology*
Science and technology policy
Briavel Holcomb, *Professor of Urban Studies and Community Health, EJBSPPP; Ph.D., Colorado*
Environment and behavior; urban revitalization
James W. Hughes, *Professor of Urban Planning and Dean, EJBSPPP; Ph.D., Rutgers*
Housing; demographic and economic analysis
Radha Jagannathan, *Assistant Professor of Urban Studies and Community Health, EJBSPPP; Ph.D., Princeton*
Statistics and methods; public welfare
Donald A. Krueckeberg, *Associate Dean and Professor of Urban Planning, EJBSPPP; Ph.D., Pennsylvania*
Urban analysis, history, property and land use
Robert W. Lake, *Professor of Urban Planning, EJBSPPP; Ph.D., Chicago*
Urban spatial structure; locational conflict; race and housing
David Listokin, *Professor of Urban Planning, CUPR; Ph.D., Rutgers*
Housing; land use; finance
Jane Miller, *Associate Professor of Urban Studies and Community Health, EJBSPPP; Ph.D., Pennsylvania*
Maternal and infant health; demography
Anton Nelessen, *Associate Professor of Urban Planning, EJBSPPP; M.A., Harvard*
Urban design; site and master planning; media presentations
Kathe Newman, *Assistant Professor of Planning and Public Policy, EJBSPPP; Ph.D., CUNY*
Urban politics; urban revitalization; community development
Frank Popper, *Professor of Urban Studies and Community Health, EJBSPPP; Ph.D., CUNY*
Urban politics; urban revitalization; community development
John R. Pucher, *Professor of Urban Planning, EJBSPPP; Ph.D., Massachusetts Institute of Technology*
Urban transportation; urban and public-sector economics
William Rodgers, *Professor of Planning and Public Policy, EJBSPPP; Ph.D., Harvard*
Labor economics; economics of social problems
Julia Sass Rubin, *Assistant Professor of Planning and Public Policy, EJBSPPP; Ph.D., Harvard*
Community economic development; developmental finance; nonprofit and hybrid organizational forms
Dona Schneider, *Professor of Urban Studies and Community Health, EJBSPPP; Ph.D., Rutgers*
Morbidity and mortality patterns for children and high risk groups
David C. Schwartz, *Professor of Urban Studies and Community Health; Director, American Affordable Housing; Ph.D., Massachusetts Institute of Technology*
Housing policy; housing finance; housing/health care relationship
Stuart Shapiro, *Assistant Professor of Planning and Public Policy, EJBSPPP; Ph.D., Harvard*
Public administration; public policy; regulatory processes; quantitative methods

Peter Simmons, *Professor of Law, SL–N; LL.B., California (Berkeley)*
Land use; housing; municipal law
Meredeth Turshen, *Professor of Urban Studies and Community Health, EJBSPPP;*
Ph.D., Sussex
Political economy of health; third world social policy
Carl Edward Van Horn, *Professor of Public Policy, EJBSPPP; Ph.D.,*
Ohio State
American political institutions; public policy
Lyna L. Wiggins, *Associate Professor of Urban Planning, EJBSPPP; Ph.D.,*
California (Berkeley)
GIS; computer applications in planning
Nancy Wolff, *Associate Professor of Urban Studies and Community Health,*
EJBSPPP; Ph.D., Iowa State
Health economics; public finance
Cliff Zukin, *Professor of Public Policy, EJBSPPP; Ph.D., Ohio State*
Mass media and American politics; public opinion and voting behavior;
survey research

Associate Members of the Graduate Faculty

Caron Chess, *Associate Professor of Human Ecology; Director, Center for*
Environmental Communication; Ph.D., New York
Public participation and deliberation; communication concerning
environmental issues
Frank Fischer, *Professor of Political Science and Public Administration, FAS–N;*
Ph.D., New York
Science, technology, and environmental policy
Edward Ramsamy, *Assistant Professor of Africana Studies; Ph.D., Rutgers*
Social theory and urban planning; international development

Program

The doctor of philosophy degree in urban planning and policy development is designed for students interested in urban planning, public policy, and public health and seeking a career in university teaching and research, advanced-policy research in the public sector, or basic research in the private sector. The faculty admits only exceptional students who can be expected to complete the program. There is no full-time residency requirement for doctoral students and no language requirement unless the faculty decides otherwise. However, prior to their qualifying examinations, students must register for at least 6 course work credits (equivalent of two classes) per term.

Applicants should have a master's degree, although some exceptional students are admitted directly after earning a bachelor's degree. In general, however, applicants who have not completed work on an advanced degree are admitted to the program only after they have completed satisfactorily 24 credits in a master's program. Until they are admitted to the doctoral program, students are considered to be enrolled only in a master's program.

Students with a master's degree must complete a minimum of 48 credits of course work and 24 credits of thesis research. If the faculty approves, students may transfer as many as 24 credits from their master's program. Students entering the program without a master's degree must complete a minimum of 63 credits of course work.

Applicants to the Ph.D. program must provide evidence of their research abilities and a full résumé in addition to the normal application requirements. Evaluation of applicants will be performed by those faculty members on the Committee on Doctoral Programs (CDP).

Students may transfer as many as 24 credits from graduate courses completed at other institutions. All transfers are subject to conditions outlined in this catalog and to the judgment of the CDP Normally, students are not permitted to transfer credits from studio-type courses, independent or directed studies, or master's thesis research.

While studying for the doctoral degree, the student works closely with a faculty adviser and meets with doctoral faculty in preparing a course of study. Program participants must take at least 9 credits of planning theory and methods courses. Relevant theory and methods courses include: 16:970:624 Planning, Public Policy, and Social Theory, 16:970:626 Advanced Scholarly Research, 34:970:630 Discrete Choice Methods, and 34:833:628 Advanced Qualitative Methods.

Please consult the Edward J. Bloustein School of Planning and Public Policy catalog for a detailed description of this degree and all its requirements.

Graduate Courses

16:970:624. PLANNING, PUBLIC POLICY, AND SOCIAL THEORY (3)
Lake. Required course for Ph.D. program.
Contemporary social theory applied to planning and policy; the role of the state in globalization, space, and scale; gender, race, and culture; citizenship, ethics, and social justice.

16:970:626. ADVANCED SCHOLARLY RESEARCH (3)
Krueckeberg. Prerequisite: Permission of instructor. Required course for
Ph.D. program.
Doctoral-level study of scholarly exposition, peer research review, and the preparation of research proposals. Students prepare proposals encompassing doctoral-level synthesis of theory and analytic methods.

16:970:701,702. RESEARCH IN URBAN PLANNING (BA,BA)
Thesis research.
These required courses are listed through the Edward J. Bloustein School of Planning and Public Policy.

34:970:630. DISCRETE CHOICE METHODS (3)
Jagannathan. Required course for Ph.D. program.
Review of linear regression; categorical dependent variables. Methods include linear probability, logit, probit, multinomial and conditional logit models.

34:833:628. ADVANCED QUALITATIVE METHODS (3)
Rubin. Required course for Ph.D. program.
Techniques of qualitative research, including interviewing, ethnography, and phenomenology; appropriate applications.

Additional courses are offered by the Edward J. Bloustein School of Planning and Public Policy in support of their programs leading to degrees of master of city and regional planning, master of public policy, and master of public affairs and politics. They include many courses that form part of the curriculum for Ph.D. students in urban planning and policy development. For additional information on these courses, please see the catalog of the Edward J. Bloustein School of Planning and Public Policy.

URBAN PLANNING, CITY AND REGIONAL

(See the catalog of the Edward J. Bloustein School of Planning and Public Policy for information about degree programs in this area.)

VISUAL ARTS

(See the catalog of the Mason Gross School of the Arts for information about the program leading to the master of fine arts in visual arts.)

WIRELESS COMMUNICATIONS CERTIFICATE

Program Offered: Certificate in Wireless Communications
Director of the Certificate Program in Wireless Communications:
Professor Christopher Rose, Rutgers, The State University of New Jersey, Wireless Information Network Laboratory (WINLAB), 73 Brett Road, Piscataway, NJ 08855-0909 (732/445-5250)

Participating Faculty

The following members and associate members of the graduate faculty, identified more fully under the electrical and computer engineering section, represent part of the faculty who participate regularly in the certificate program in wireless communications:

Dipankar Raychaudhuri, *Director, WINLAB*
Narayan Mandayam, *Associate Director, WINLAB*
Christopher Rose, *Associate Director, WINLAB*
Roy Yates, *Associate Director, WINLAB*
David G. Daut
Predrag Spasojevic
Wade Trappe

Certificate Program

In response to the demand for qualified engineers in the wireless-networking community, the Wireless Information Network is offering a Certificate in Wireless Communications.

The program provides a background in telecommunications combined with specialized instruction in wireless communications. The curriculum is flexible to meet individuals' different educational needs. Some may wish to take the two electives as preparation for the two required courses, while others will take the electives for more specialized training. The graduate courses are applied toward advanced-degree programs, subject to the program's requirements. Participating faculty are drawn from members of the graduate faculty in electrical engineering.

WINLAB is an industry/university collaborative venture aimed at furthering the interests of the wireless networking community. Its activities include research, technology evaluation, and education. The Rutgers Department of Electrical and Computer Engineering offers education in wireless networking at the bachelor's, master's, and Ph.D. levels. A student pursuing an advanced degree will be admitted to the certificate program upon approval of the director. Four courses with a minimum GPA of 3.0 are required for the certificate.

Required Courses

Four courses (two required courses and two electives) with a minimum GPA of 3.0 are required.

16:332:543   Communications Networks I (3) or 14:332:423 Telecommunication Networks (3)
14:332:546   Wireless Communications Technologies (proposed) or 14:332:426 Wireless Personal Communications Systems (3)

Elective Courses

14:332:321   Probability and Random Processes (3) (if not previously completed)
14:332:322   Principles of Communication Systems (3) (if not previously completed)
14:332:421   Communications Engineering (3) (if not previously completed)
14:332:481   Electromagnetic Waves (3) (if not previously completed)
16:332:541   Stochastic Signals and Systems (3)
16:332:544   Communications Networks II (3)
16:332:545   Communication Theory (3)
16:332:547   Digital Communications I (3)
16:332:548   Digital Communications II (3)
16:332:601   Special Problems: Wireless Communications Project (BA)

WOMEN'S AND GENDER STUDIES 988

Programs Offered: **Master of Arts in Women's and Gender Studies; Certificate in Women's and Gender Studies; Ph.D.**
Director of the Graduate Program in Women's and Gender Studies:
   Professor Mary Hawkesworth, Ruth Dill Johnson Crockett Building, Douglass Campus (732/932-9331)
Web Site: *http://womens-studies.rutgers.edu*

Members of the Graduate Faculty

Laura Ahearn, *Assistant Professor of Anthropology, FAS–NB; Ph.D., Michigan*
   Linguistic anthropology, gender, social change, kinship; Nepal, South Asia
Eileen Appelbaum, *Professor of Labor Studies, SMLR; Ph.D., Pennsylvania*
   Economics
Emily Bartels, *Associate Professor of English, FAS–NB; Ph.D., Harvard*
   Renaissance dramatic literature; colonialist discourse
Frances Bartkowski, *Associate Professor of English, FAS–N; Ph.D., Iowa*
   Comparative literature
Vilna Bashi, *Assistant Professor of Sociology, FAS–NB; Ph.D., Wisconsin*
   Race, immigration, labor markets
Mia Elisabeth Bay, *Associate Professor of History, FAS–NB; Ph.D., Yale*
   African-American history; American intellectual and cultural history
Eleanor Brilliant, *Professor of Social Work, SSW; D.S.W., Columbia*
   Community planning, organizational behavior, and social policy; women's leadership
Ethel Brooks, *Assistant Professor of Women's and Gender Studies and Sociology, FAS–NB; Ph.D., New York*
   Gender and labor; critical political economy; globalization
Charlotte Bunch, *Professor of Women's and Gender Studies, FAS–NB, and Director of the Center for Women's Global Leadership; B.A., Duke*
   Gender and development; women's human rights; violence against women; women's global leadership
Abena Busia, *Associate Professor of English and Women's and Gender Studies, FAS–NB; D.Phil., Oxford*
   Black African women in British and American fiction
Susan Carroll, *Professor of Political Science and Women's and Gender Studies, FAS–NB/EIP; Ph.D., Indiana*
   Women and politics; mass politics
Indrani Chatterjee, *Associate Professor of History, FAS–NB; Ph.D. London*
   Slavery, history of women and sexuality, law, and the cultural and intellectual histories of family
Christine Chism, *Assistant Professor of English, FAS–NB; Ph.D., Duke*
   Medieval literature, drama, women's and gender studies, cultural studies, historiography
Susan Cobble, *Professor of Labor Studies and Women's and Gender Studies, SMLR; Ph.D., Stanford*
   Women and work; labor history; union leadership
Ed Cohen, *Associate Professor of English and Women's and Gender Studies, FAS–NB; Ph.D., Stanford*
   Literary and social theory; gay and gender studies; late Victorian culture
Ann Baynes Coiro, *Associate Professor of English, FAS–NB; Ph.D., Maryland*
   Renaissance and 17th-century literature
Barbara Cooper, *Associate Professor of African Studies, History, and Women's and Gender Studies, FAS–NB; Ph.D., Boston*
   African history; Muslim women
Drucilla Cornell, *Professor of Political Science and Women's and Gender Studies, SL–N; J.D., California (Los Angeles)*
   Feminist jurisprudence; critical theory
Sheila Cosminsky, *Associate Professor of Sociology and Anthropology, FAS–C; Ph.D., Brandeis*
   Cultural and medical anthropology; ethnic relations; Mesoamerica; Africa
Jeanette Covington, *Associate Professor of Sociology, FAS–NB; Ph.D., Chicago*
   Deviance/criminology
Cynthia Daniels, *Associate Professor of Political Science, FAS–NB; Ph.D., Massachusetts (Amherst)*
   Women and public policy; reproductive politics; political economy of gender
Harriet A. Davidson, *Associate Professor of English and Women's and Gender Studies, FAS–NB; Ph.D., Vanderbilt*
   Modern and contemporary poetry; critical theory
Belinda Davis, *Associate Professor of History, FAS–NB; Ph.D., Michigan (Ann Arbor)*
   Modern European history; Germany; women's history
Marianne DeKoven, *Professor of English and Women's and Gender Studies, FAS–NB; Ph.D., Stanford*
   Modernism; women's and gender studies
Elin Diamond, *Professor of English, FAS–NB; Ph.D., California (Davis)*
   Drama and dramatic theory; feminist and literary theory
M. Josephine Diamond, *Professor of French and Women's and Gender Studies, FAS–NB; Ph.D., Cornell*
   Nineteenth- and 20th-century literature; critical theory
William C. Donahue, *Associate Professor of German, FAS–NB; Ph.D., Harvard*
   Nineteenth- and 20th-century literature; German-Jewish studies
Kate Ellis, *Associate Professor of English, FAS–NB; Ph.D., Columbia*
   Women's and gender studies; 18th-century fiction
David Eng, *Associate Professor of English, FAS–NB; Ph.D., California (Berkeley)*
   Asian American literature, queer theory, sexualities
Leela Fernandes, *Associate Professor of Political Science and Women's and Gender Studies, FAS–NB Ph.D., Chicago*
   Women's and gender studies; comparative politics; political economy and cultural studies; South Asia
Leslie Fishbein, *Associate Professor of American Studies, FAS–NB; Ph.D., Harvard*
   American studies

Jerry Flieger, *Professor of French, FAS–NB; Ph.D., California (Berkeley)*
Twentieth-century literature; critical theory; women's and gender studies and feminist theory

Sandy Flitterman-Lewis, *Associate Professor of English, FAS–NB; Ph.D., California (Berkeley)*
Feminist cultural analysis with an emphasis on film and literature

Lora D. Garrison, *Professor of History and Women's and Gender Studies, FAS–NB; Ph.D., California (Irvine)*
Women and reform movements; recent U.S. history

Judith Gerson, *Associate Professor of Sociology and Women's and Gender Studies, FAS–NB; Ph.D., Cornell*
Gender; work; social theory

Sherry Gorelick, *Associate Professor of Sociology and Women's and Gender Studies, FAS–NB; Ph.D., Columbia*
Education; ethnicity

Mary Gossy, *Associate Professor of Spanish and Women's and Gender Studies, FAS–NB; Ph.D., Harvard*
Golden-age prose, narrative, feminist theory, reader-response, psychoanalysis

Elizabeth Grosz, *Professor of Women's and Gender Studies, FAS–NB; Ph.D., Sydney*
French philosophy, theories of space and time

Sandra Harris, *Professor of Psychology, FAS–NB/GSAPP; Ph.D., SUNY (Buffalo)*
Autism

Mary S. Hartman, *Professor of History, FAS–NB; Ph.D., Columbia*
Nineteenth-century France; women's history

Angelique Haugerud, *Associate Professor of Anthropology, FAS–NB; Ph.D., Northwestern*
Economic and political anthropology, Agrean ecology, social change and development; Africa

Mary E. Hawkesworth, *Professor of Women's and Gender Studies, FAS–NB; Ph.D., Georgetown*
Political philosophy, feminist theory, women and politics

Nancy Hewitt, *Professor of History and Women's and Gender Studies, FAS–NB; Ph.D., Pennsylvania*
American women; 19th-century U.S. history

Dorothy Hodgson, *Associate Professor of Anthropology, FAS–NB; Ph.D., Michigan*
Cultural anthropology; politics of development; culture and power; gender

Briavel Holcomb, *Professor of Urban Studies, EJBSPPP; Ph.D., Colorado*
Urban revitalization; environment and behavior; women

Beth Hutchison, *Associate Director, Institute for Research on Women, FAS–NB; Ph.D., Washington*
Contemporary feminist theory; narrative film theory and practice; lesbian/gay studies

Jennifer Jones, *Associate Professor of History, FAS–NB; Ph.D., Princeton*
Medieval and early modern European; France, old regime and revolution; European women's history

Jane Junn, *Associate Professor of Political Science, FAS–NB; Ph.D., Chicago*
Methodology, American politics

Samira Kawash, *Assistant Professor of English and Women's Studies, FAS–NB; Ph.D., Duke*
Nineteenth- and 20th-century minority and African-American literature; cultural theory; race and ethnicity

Daphne Lamothe, *Assistant Professor of English, FAS–NB; Ph.D., California (Berkeley)*
African-American fiction, black Atlantic culture and theories of migration, ethnography, folk culture

Renée Larrier, *Associate Professor of French, FAS–NB; Ph.D., Columbia*
African and Caribbean literature in French

Suzanne Lebsock, *Professor of History, FAS–NB; Ph.D., Virginia*
History of women, U.S. social history, history of the south

Barbara Lee, *Professor of Human Resource Management and Dean, SMLR; Ph.D., Ohio; J.D., Georgetown*
Employment discrimination; disability and work

Barbara Lewis, *Associate Professor of Political Science, FAS–NB; Ph.D., Northwestern*
Comparative politics (Africa); women and politics

Phyllis Mack, *Professor of History and Women's and Gender Studies, FAS–NB; Ph.D., Cornell*
Early modern French and English history; women's history

Ruth Mandel, *Board of Governors Professor of Politics and Director of the Eagleton Institute of Politics; Ph.D., Connecticut*
Women's participation in American politics

Joan Marter, *Professor of Art History, FAS–NB; Ph.D., Delaware*
Modern art; 20th-century art; gender studies; museum studies

Leslie McCall, *Associate Professor of Sociology and Women's and Gender Studies, FAS–NB; Ph.D., Wisconsin*
Gender; work and labor markets; theory

Paula McDowell, *Associate Professor of English, FAS–NB; Ph.D., Stanford*
Eighteenth-century British literature

Meredith McGill, *Assistant Professor of English, FAS–NB; Ph.D., Johns Hopkins*
Nineteenth-century women's poetry; women and the literary marketplace

Jennifer Morgan, *Assistant Professor of History and Women's Studies, FAS–NB; Ph.D., Duke*
Early American history; African-American women's history

Alicia Ostriker, *Professor of English, FAS–NB; Ph.D., Harvard*
American and modern literature; criticism

Ann Parelius, *Associate Professor of Sociology, FAS–NB; Ph.D., Chicago*
Education

Gerald Pirog, *Associate Professor of Slavic Languages and Literatures, FAS–NB; Ph.D., Yale*
Slavic languages and literatures

Jasbir Puar, *Assistant Professor of Women's Studies and Geography, FAS–NB; Ph.D., California (Berkeley)*
Gender and globalization, diaspora, tourism, queer theory, transnational sexuality

Nancy Rao, *Assistant Professor of Music, MGSA; Ph.D., Michigan*
Music theory, 20th-century American music, women composers 1900–1950, and contemporary Chinese composers

Joanna Regulska, *Professor of Geography and Women's and Gender Studies, FAS–NB; Ph.D., Colorado*
Urban policy; planned-market economy; geography of women

Donald T. Roden, *Associate Professor of History, FAS–NB; Ph.D., Wisconsin*
Modern Japanese social and intellectual history

Patricia Roos, *Professor of Sociology, FAS–NB; Ph.D., California (Los Angeles)*
Stratification; work; gender

Sarah Rosenfield, *Associate Professor of Sociology, FAS–NB; Ph.D., Texas*
Medical sociology; mental illness

Phillip Rothwell, *Assistant Professor of Spanish and Portuguese; FAS–NB; Ph.D., Cambridge*
Women in African literature

Paul Schalow, *Associate Professor of Japanese, FAS–NB; Ph.D., Harvard*
Japanese literature (Edo period); gender and sexuality in Japanese literature; Japanese women's writing

Louisa Schein, *Associate Professor of Anthropology and Women's and Gender Studies, FAS–NB; Ph.D., California (Berkeley)*
Cultural politics, ethnicity, gender, transnational issues, China

Joan Scott, *Professor of Social Science; Institute for Advanced Study; Ph.D., Wisconsin*
Feminist history and theory

Richard Serrano, *Assistant Professor of French and Comparative Literature; Ph.D., California (Berkeley)*
French literature, comparative literatures

Ben. Sifuentes-Jáuregui, *Assistant Professor of Spanish, FAS–NB; Ph.D., Yale*
Twentieth-century Spanish-American literature and cultural studies, gender theory and psychoanalysis; U.S. Latino literature

Bonnie G. Smith, *Professor of History and Women's and Gender Studies, FAS–NB; Ph.D., Rochester*
Modern European history; women's history

Carol Smith, *Professor of English, FAS–NB; Ph.D., Pittsburgh*
The novel; critical theory

Arlene Stein, *Associate Professor of Sociology, FAS–NB; Ph.D., California (Berkeley)*
Sociology of gender and sexuality

Linda Steiner, *Associate Professor of Journalism and Mass Media, SCILS; Ph.D., Illinois (Urbana)*
Feminist theorizing, communication ethics; feminist and alternative media

Judith Stern, *Professor of Psychology, FAS–NB; Ph.D., Rutgers*
Sexual and maternal behaviors in animals and women

Sarolta Takács, *Associate Professor of Classics; Ph.D., California (Los Angeles)*
Roman and Byzantine history, women and religion

Gayle Tate, *Associate Professor of Africana Studies, FAS–NB; Ph.D., CUNY*
African-American women and politics

Meredeth Turshen, *Associate Professor of Urban Planning, EJBSPPP; Ph.D., Sussex*
Political economy of health; third world social policy

Cheryl Wall, *Professor of English, FAS–NB; Ph.D., Harvard*
American and African-American literature

Michael D. Warner, *Professor of English, FAS–NB; Ph.D., Johns Hopkins*
Colonial and 19th-century American literature; queer theory; social theory

Deborah White, *Professor of History and Women's and Gender Studies, FAS–NB; Ph.D., Illinois*
African-American history, women's history

Carolyn S. Williams, *Associate Professor of English, FAS–NB; Ph.D., Virginia*
Victorian literature; women's studies, cultural studies

Virginia Yans-McLaughlin, *Professor of History, FAS–NB; Ph.D., SUNY (Buffalo)*
U.S. cultural history; women's history; history of immigration

Chün-Fang Yü, *Professor of Religion, FAS–NB; Ph.D., Columbia*
Buddhism, Chinese religions; religion and gender

Yael Zerubavel, *Professor of Jewish Studies and History, FAS–NB; Ph.D., Pennsylvania*

Associate Members of the Graduate Faculty

Cheryl Clarke, *Director of Diverse Community Affairs and Lesbian/Gay Concerns;*
Ph.D., Rutgers
English; feminist poetry, African American women's literature, lesbian studies
Mary Trigg, *Program Director, Institute for Women's Leadership and Associate*
Director, Center for Women and Work

Adjunct Member of the Graduate Faculty

Barbara Balliet, *Associate Director of Women's and Gender Studies, FAS–NB;*
Ph.D., New York
U.S. social history; women's history

Programs

The interdisciplinary Ph.D. program in women's and gender studies provides advanced and systematic course work investigating gender in society and culture in historical and contemporary contexts from multicultural and multiracial perspectives. The graduate course offerings are designed to explore the intricate connections between feminist theory and practice, to illuminate the centrality of the intersection of gender identities with other socially and culturally produced identities, and to investigate women's issues and gender issues in a global context. The program includes 18 hours of core courses and 21 hours of course work within three areas of concentration, in addition to the successful completion of qualifying examinations and a doctoral dissertation.

The M.A. program is a liberal arts degree providing students with an opportunity to pursue advanced interdisciplinary work in women's and gender studies, enabling them to become active practitioners in this rapidly expanding field of study. The program is structured as a "terminal" master's degree, but does offer preparation for more advanced work at the doctoral level and serves as a supplement for professional degrees in fields such as law, social work, public health, labor studies, public policy, or clinical psychology. With an increasing emphasis on careers focusing on the delivery of services to women and a rethinking of the needs of women and families worldwide, women's and gender studies helps to fill a growing demand for experts versed in women and gender issues. The M.A. program is designed to emphasize global and multicultural perspectives on these matters.

Certificate Program

Rutgers is unusual in offering both a graduate certificate in women's and gender studies and Ph.D. concentrations on women and gender in several major disciplines: English, history, sociology, and political science. Students in a graduate program with a women's and gender studies track and those whose programs lack a women's and gender studies area can take a special concentration in women's and gender studies as part of their regular, advanced-degree program. Upon receiving that advanced degree, these students also will get a graduate certificate in women's and gender studies. The special requirements for the certificate, many of which also may be used to satisfy the student's graduate degree requirements, are as follows: one feminist theory course and two 988 (women's and gender studies) courses.

Graduate Courses in Women's and Gender Studies

16:988:510. TECHNOLOGIES AND POETICS OF GENDER AND SEXUALITY (3)
Prerequisite: Permission of instructor.
Technologies and poetics through which sexuality and gender are constructed; the ways in which cross-culturally and historically the gendered and sexed body has been socially and culturally produced.

16:988:515. FEMINISM: THEORY AND PRACTICE (3)
Prerequisite: Permission of instructor.
Considers the nature and extent of transformations feminists have achieved in specific areas, the continuing issues that need to be addressed to realize visions of social justice, and the complex theoretical issues raised by feminist praxis.

16:988:520. AGENCY, SUBJECTIVITY, AND SOCIAL CHANGE (3)
Prerequisite: Permission of instructor.
The relationship between women, gender, and movements for social, political, and cultural changes in historical and cross-cultural contexts.

16:988:525. COLLOQUIUM IN WOMEN'S AND GENDER STUDIES (3)
Prerequisite: Permission of instructor.
Topic varies according to specialization of instructor.

16:988:530. GENDERED BORDERS/CHANGING BOUNDARIES (3)
Prerequisite: Permission of instructor.
Social, political, and epistemological role of gender in the construction of boundaries and borders in a global, transnational context.

16:988:582. FEMINIST GENEALOGIES (3)
Prerequisite: Permission of instructor.
Development of modern feminist thought since the 18th century. Exploration of key modern theories that underlie feminist thought, including liberalism, Marxism, psychoanalysis, and existentialism.

16:988:583. CONTEMPORARY FEMINIST THEORIES (3)
Prerequisite: Permission of instructor.
Contemporary feminist theories and debates in local and global contexts. Explores the connection of feminist theory since 1945 with intellectual movements, ranging from structuralism and cultural studies to postmodernism.

16:988:584,585. PRACTICUM IN WOMEN'S AND GENDER STUDIES (3,3)
Prerequisite: Permission of instructor.
Field work for M.A. degree candidates.

16:988:590. INDEPENDENT STUDY: WOMEN'S AND GENDER STUDIES (3)
Prerequisite: Permission of instructor.

16:988.602. FEMINIST METHODOLOGIES (3)
Prerequisite: Permission of instructor.
Feminist knowledge production; philosophical, methodological, theoretical, and disciplinary traditions. Key debates over processes and terms of feminist knowledge production.

16:988:603. FEMINIST KNOWLEDGE PRODUCTION (3)
Prerequisite: Permission of instructor.
Introduces a broad range of interdisciplinary feminist research methods to enable students to develop and design their own independent-research projects.

16:988:701,702. RESEARCH IN WOMEN'S AND GENDER STUDIES (3,3)
Prerequisite: Permission of instructor.

Graduate Cognate Courses

Description for the courses listed below can be found elsewhere in this catalog or in that of one of the professional schools. Students should inquire at the office of the graduate program offering a particular course to determine the specific topic of the course that term.

Anthropology

16:070:510. SOCIAL IMPLICATIONS OF GENDER DIFFERENCES (3)

16:070:511. ANTHROPOLOGY OF GENDER (3)

16:070:516. SEXUALITY IN A CROSS-CULTURAL PERSPECTIVE (3)

16:070:527. THE ETHNOLOGY OF INEQUALITY: RACE, CLASS, AND ETHNICITY (3)

16:070:548. TRANSNATIONALISM AND GLOBALIZATION (3)

Art History

16:082:509. AFRICAN ART AND ARCHITECTURE (3)

16:082:630. PROBLEMS IN ITALIAN RENAISSANCE PAINTING (3)

16:082:636. TITIAN (3)

16:082:655. PROBLEMS IN 20TH-CENTURY ART: CONSTRUCTIONS OF THE FEMALE BODY (3)

16:082:657. PROBLEMS IN MODERN ART (3)

Communication, Information, and Library Studies

16:194:664. MEDIA AND CULTURE **(3)**

16:194:665. MEDIA AND POLITICS **(3)**

Comparative Literature

16:195:502. WOMEN AND WRITING **(3)**

16:195:515. STUDIES IN CONTEMPORARY LITERATURE: SOUTH ASIAN DIASPORIC NOVEL **(3)**

16:195:611. PSYCHOANALYTIC APPROACHES TO LITERATURE **(3)**

16:195:612. LITERATURE AND THE SOCIAL ORDER: TRANSNATIONALISM AND GLOBALIZATION **(3)**

16:195:613. MINORITY LITERATURES **(3)**

16:195:617. TOPICS IN ADVANCED LITERARY THEORY: POST-STRUCTURALISM AND POSTMODERNISM **(3)**

Education

16:300:595. THE PSYCHOLOGY OF SEX DIFFERENCES **(3)**

English

16:350:505. STUDIES IN POETIC FORM **(3)**

16:350:509. STUDIES IN CRITICAL METHODOLOGIES: POETRY AND FEMINISM **(3)**

16:350:510. THEORIES OF GENDER AND SEXUALITY **(3)**

16:350:515. MYTH, RELIGION, AND LITERATURE: THE BIBLE AND FEMINIST IMAGINATION **(3)**

16:350:520. STUDIES IN FILM: WOMEN AND FILM **(3)**

16:350:532. GENDER AND SEXUALITY IN MEDIEVAL LITERATURE AND CULTURE **(3)**

16:350:545. SHAKESPEARE ACROSS CULTURES **(3)**

16:350:551. GENDER AND SEXUALITY IN 18TH-CENTURY LITERATURE AND CULTURE **(3)**

16:350:570. GENDER AND SEXUALITY IN VICTORIAN LITERATURE AND CULTURE **(3)**

16:350:574. NINETEENTH-CENTURY DISCOURSES OF RACE, NATION, AND EMPIRE **(3)**

16:350:579. STUDIES IN 19TH-CENTURY AFRICAN-AMERICAN LITERATURE AND CULTURE **(3)**

16:350:588. TWENTIETH-CENTURY AFRICAN-AMERICAN LITERATURE AND CULTURE **(3)**

16:350:589. STUDIES IN AFRICAN-AMERICAN LITERATURE AND CULTURE **(3)**

16:350:593. STUDIES IN ETHNIC AMERICAN LITERATURES AND CULTURES **(3)**

16:350:605. SEMINAR: FEMINIST THEORIES AND CONTROVERSIES **(3)**

16:350:619. SEMINAR: GENDER AND SEXUALITY IN RENAISSANCE LITERATURE **(3)**

16:350:636. SEMINAR: JANE AUSTIN IN CONTEXT **(3)**

16:350:648. SEMINAR: AMERICAN WOMEN WRITERS **(3)**

16:350:655. SEMINAR: TOPICS IN AFRICAN-AMERICAN LITERATURE AND CULTURE **(3)**

French

16:420:664. TWENTIETH-CENTURY FRENCH POETRY **(3)**

16:420:669. STUDIES IN FRENCH LITERATURE OF THE 20TH CENTURY: GENDER AND GENRE **(3)**

16:420:679. STUDIES IN FILM AND FILM THEORY **(3)**

16:420:682. PERSPECTIVES OF CONTEMPORARY CRITICISM **(3)**

Geography

16:450:520. WOMEN IN THE URBAN ENVIRONMENT **(3)**

16:450:525. RESTRUCTURING OF CENTRAL AND EASTERN EUROPE AFTER 1989 **(3)**

German

16:470:662. GERMAN FEMINIST WRITERS **(3)**

History

16:510:519. COLLOQUIUM IN INTELLECTUAL HISTORY **(3)**

16:510:523. COLLOQUIUM IN MIGRATION, COMMUNITY, AND IDENTITY **(3)**

16:510:529. TOPICS IN THE HISTORY OF SEXUALITY **(3)**

16:510:539. COLLOQUIUM IN WOMEN'S AND GENDER HISTORY **(3)**

16:510:549. SEMINAR IN THE HISTORY OF WOMEN **(3)**

16:510:555. PROBLEMS AND DIRECTED READINGS IN AMERICAN HISTORY I **(3)**

16:510:560. PROBLEMS AND DIRECTED READINGS IN WOMEN'S AND GENDER HISTORY **(3)**

16:510:563. COLLOQUIUM IN AFRICAN-AMERICAN HISTORY **(3)**

Labor Studies

38:578:541. WOMEN AND WORK **(3)**

38:578:551. SEMINAR IN MINORITIES AND WORK **(3)**

Literature and Language

16:617:510. INTRODUCTION TO LITERARY THEORY **(3)**

16:617:514. INTRODUCTION TO FILM THEORY AND ANALYSIS **(3)**

Political Science

16:790:578. FEMINISM IN POSTMODERNITY **(3)**

16:790:584. THEMES IN FEMINIST THEORY IN POLITICS **(3)**

16:790:587. PROSEMINAR IN WOMEN AND POLITICS **(3)**

16:790:588. GENDER AND MASS POLITICS **(3)**

16:790:589. WOMEN AND POLITICAL LEADERSHIP **(3)**

16:790:590. GENDER AND POLITICAL THEORY **(3)**

16:790:591. GENDER AND PUBLIC POLICY **(3)**

16:790:592. POLITICS, DEVELOPMENT, AND WOMEN **(3)**

16:790:594. WOMEN'S MOVEMENTS IN COMPARATIVE PERSPECTIVE **(3)**

16:790:596. ADVANCED TOPICS IN WOMEN AND POLITICS **(3)**

16:790:635. FRENCH FEMINIST THEORY **(3)**

16:790:672. INDEPENDENT STUDY IN WOMEN AND POLITICS **(3)**

Graduate School of Applied and Professional Psychology: Clinical Psychology

18:820:579. GENDER AND PSYCHOTHERAPY **(3)**

Public Policy

34:833:680. SEMINAR IN PUBLIC POLICY: PLANNING POLICY AND RACE **(3)**

School of Social Work

19:910:564. WOMEN'S ISSUES **(3)**

19:910:585. ISSUES IN SOCIAL POLICY: CHILDREN AND FAMILIES **(3)**

16:610:646. FAMILY THEORY AND PROGRAM DEVELOPMENT **(3)**

Sociology

16:920:528. MARRIAGE AND THE FAMILY **(3)**

16:920:570. SPECIAL TOPICS IN SOCIOLOGY: SOCIAL INEQUALITY, POLITICAL AND ECONOMIC DIMENSIONS **(3)**

16:920:571. SPECIAL TOPICS IN SOCIOLOGY: SEMINAR IN GENDER AND SEXUALITY **(3)**

16:920:602. CULTURE, SYMBOLS, AND SOCIAL INTERACTION **(3)**

16:920:614. SEMINAR IN RACE AND ETHNIC RELATIONS **(3)**

16:920:618. SOCIOLOGY OF GENDER **(3)**

16:920:632. SOCIOLOGY OF WORK **(3)**

16:920:640. SOCIOLOGICAL PERSPECTIVES ON FEMINIST THEORY **(3)**

Research Centers, Bureaus, and Institutes

The university sponsors many centers, bureaus, and institutes that are the loci of its mission-oriented research. Many of these contain the principal offices of members of the graduate faculty, whose research activity takes place under their auspices. Students enrolled in the Graduate School–New Brunswick may find that their own research activity is located at and funded through these centers, bureaus, and institutes. This chapter lists those that are likely to be sites of graduate student research at the Graduate School–New Brunswick.

Biotechnology Center for Agriculture and the Environment (BCAE)

Foran Hall
59 Dudley Road, Cook Campus
New Brunswick, NJ 08901-8520
Telephone: 732/932-8165; Fax: 732/932-6535
biotech@njaes.rutgers.edu
Gerben J. Zylstra, *Director*

The Biotechnology Center for Agriculture and the Environment (BIOTECH) is an integral part of the New Jersey Agricultural Experiment Station. BIOTECH carries out research and training in molecular biology applied to agriculture and the environment and transfers new discoveries into practice and product development. Research on plant systems is concerned with fungal and viral disease resistance, sulfate metabolism, natural products and the regulation of plant development, turfgrass transformation, and the use of plants to remedy heavy metal and radionuclide pollution. Bioremediation research also seeks new tools and methods to degrade industrial and other toxic wastes using aerobic and anaerobic microorganisms to minimize pollution on land, freshwater, coastal, and offshore marine environments.

Center for Advanced Biotechnology and Medicine (CABM)

679 Hoes Lane, Busch Campus
Piscataway, NJ 08854-5627
Telephone: 732/235-5300; Fax: 732/235-4850
Aaron J. Shatkin, *Director*

The Center for Advanced Biotechnology and Medicine (CABM) is administered jointly by Rutgers, The State University of New Jersey, and the University of Medicine and Dentistry of New Jersey. It is designated by the New Jersey Commission on Science and Technology as one of the state's advanced technology centers. In addition to the two universities and the commission, the center's constituencies include the New Jersey pharmaceutical and related biotechnology industries; the National Institutes of Health; the National Science Foundation; and private organizations that support

science and technology, including the Howard Hughes Medical Institute. The mission of CABM is the advancement of knowledge in the life sciences for the improvement of human health. To improve the understanding of fundamental life processes, CABM performs basic research in the areas of cell and developmental biology, molecular genetics, and structural biology. Researchers interact with clinical scientists to bring laboratory discoveries to patient care. CABM faculty train undergraduate, graduate, and postdoctoral students for leadership in science and technology. CABM serves the public interest by enhancing economic development through corporate collaborations in research and education, by technology transfers, and through consultations.

Center for Advanced Food Technology (CAFT)

Nabisco Institute for Advanced Food Technology
65 Dudley Road, Cook Campus
New Brunswick, NJ 08901-8520
Telephone: 732/932-8306; Fax: 732/932-8690
kokini@aesop.rutgers.edu
Jozef L. Kokini, *Director*

The Center for Advanced Food Technology (CAFT) is a unique, cooperative venture between the food industry, academia, and government. It strives to create and enhance applications of scientific knowledge and technologies that address product, process, and manufacturing needs for the delivery of high-quality, health-promoting foods and food materials to consumers. Research programs involve about 30 faculty members, staff, and students from 10 university departments. In the Cooperative Research and Technology Transfer Program, multidisciplinary teams carry out precompetitive and targeted research in the areas of materials science, flavor science, safety and health promotion in processed foods, and nutraceuticals. In the Advanced Manufacturing and Outreach Program, multidisciplinary teams research, develop, demonstrate, and assist in commercialization of packaged food manufacturing technologies using a full-scale demonstration manufacturing plant. The CAFT Instrumentation Support Facilities Program provides research, development, and training activities focused upon mass spectrometry and chromatography, spectroscopy and calorimetry, and rheological measurements and extrusion cooking. Economic and human-resource development are integrated with the discovery of new knowledge and the transfer of technologies throughout CAFT programs.

Center for Advanced Information Processing (CAIP)

CoRE Building
96 Frelinghuysen Road, Busch Campus
Piscataway, NJ 08854-8008
Telephone: 732/445-3443; Fax: 732/445-0547
James Flanagan, *Director*

The Center for Advanced Information Processing (CAIP) is a multidisciplinary Advanced Technology Center sponsored by the New Jersey Commission on Science and Technology; Rutgers, The State University of New Jersey; and 21 industrial and corporate sponsors. CAIP conducts computer applications research in the areas of parallel and distributed computing, machine vision, speech processing, computer-aided design, scientific visualization and quantification and multimedia information systems, and facilitates industry-university technology transfer. CAIP's research mission is to apply the technologies of

high-speed scientific computing to the solution of industrial problems. Computational resources include:

- Sun Microsystems Enterprise 10000, Sun's highest-end multiprocessor server: 128 CPUs, 512 MB per processor, and approximately 3/4 TB of disk storage
- IBM SP2 multiprocessor system: 8 CPUs
- 20 Sun SparcServer-20/62s, each with 2 CPUs and between 192 MB and 512 MB of RAM
- A Beowolf cluster in the Applied Software Systems Lab (TASSL): 8 dual processor Pentium IIIs

Center of Alcohol Studies (CAS)

Smithers Hall
607 Allison Road, Busch Campus
Piscataway, NJ 08854-8001
Telephone: 732/445-2190; Fax: 732/445-3500
http://www.rci.rutgers.edu/~cas2
Robert J. Pandina, *Director*

The Center of Alcohol Studies (CAS), the world's oldest alcohol research center, is a multidisciplinary institute dedicated to acquisition and dissemination of knowledge on psychoactive substance use and related phenomena. Its primary emphasis is on alcohol use and consequences. The center's core program of basic and applied research is conducted by scientists drawn chiefly from the biological sciences (principally biochemistry and neuropharmacology), psychology (clinical and experimental), and sociology. Faculty members of the Basic Sciences Division (comprised of three distinct laboratories), the Clinical Division, and the Prevention Research and Services Division are the principal contributors to this center's focus. The Information Services Division houses the center's extensive research library and a collection of more than 100,000 research and professional materials on all aspects of alcohol use and abuse. It also publishes the internationally recognized *Journal of Studies on Alcohol.* The Education and Training Division conducts continuing professional-education seminars throughout the academic year and two weeklong summer programs. The center offers graduate courses in alcohol studies to students enrolled in advanced-degree programs at Rutgers who wish to pursue a special concentration in alcohol or other substance use/abuse studies. Additionally, a number of research opportunities are available with center faculty, with the extensive network of interdisciplinary visiting professors to the center, or with one of the center's collaboration institutions. Further information may be found online.

Malcolm G. McLaren Center for Ceramic Research (MGMCCR)

607 Taylor Road, Busch Campus
Piscataway, NJ 08854-8065
Telephone: 732/445-5900; Fax: 732/445-5595
Dale E. Niesz, *Director*

The Malcolm G. McLaren Center for Ceramic Research (MGMCCR) is an Advanced Technology Center of the New Jersey Commission on Science and Technology and a National Science Foundation Industry/University Cooperative Research Center. It serves as a resource center in ceramic science and engineering for the state of New Jersey and member companies. The center is dedicated to developing advanced ceramic science and engineering and ensuring that emerging science and engineering technology is used for commercial and technological development in New Jersey and beyond. The center conducts research in a broad area of ceramic science,

engineering, and technology. It focuses on the synthesis of advanced materials with the microstructures and nanostructures needed to fulfill the property requirements as well as cost, shape, and reliability requirements of emerging applications.

Rutgers Center for Cognitive Science (RuCCS)

Psychology Building Addition
152 Frelinghuysen Road, Busch Campus
Piscataway, NJ 08854-8020
Telephone: 732/445-0635; Fax: 732/445-6715
http://ruccs.rutgers.edu
Ernest Lepore, *Director*

The Rutgers Center for Cognitive Science (RuCCS) fosters research activities in cognitive science, focusing on the nature of certain symbolic processes that are constitutive of intelligent performance. The center's goal is to understand such aspects of intelligent performance as perception, language processing, planning, problem solving, reasoning, and learning, in terms of both the computational processes that underwrite these skills and the computational mechanisms that may instantiate them. The center's research, which is multidisciplinary, is carried on in its own facilities as well as facilities throughout the university. RuCCS also contributes to graduate training through the certificate program in cognitive science.

Center for the Critical Analysis of Contemporary Culture (CCACC)

8 Bishop Place, College Avenue Campus
New Brunswick, NJ 08901-8530
Telephone: 732/932-8426; Fax: 732/932-8683
theccacc@aol.com
George Levine, *Director*

The Center for the Critical Analysis of Contemporary Culture (CCACC) was established to foster interdisciplinary research and scholarly exchange in the humanities and social sciences. Each year, the center focuses on a topic of broad interdisciplinary interest and appoints as many as 20 fellows from the full range of university disciplines. The center sponsors lecture series, colloquia, and conferences on important topics of interdisciplinary concern.

Center for Discrete Mathematics and Theoretical Computer Science (DIMACS)

CoRE Building
96 Frelinghuysen Road, Busch Campus
Piscataway, NJ 08854-8018
Telephone: 732/445-5928; Fax: 732/445-5932
http://dimacs.rutgers.edu
Fred S. Roberts, *Director*

The Center for Discrete Mathematics and Theoretical Computer Science (DIMACS) is a National Science Foundation Science and Technology Center. It also is supported by the New Jersey Commission on Science and Technology, and is a consortium of Rutgers and Princeton universities and AT&T Labs–Research, Bell Labs, Telcordia Technologies, and NEC Research. DIMACS offers workshops, seminars, and tutorials, hosts postdoctoral fellows and graduate students, and runs precollege and undergraduate programs to address topics of scientific importance. Recent sample topics include discrete and computational geometry, complexity theory of interactive computing, graph theory and algorithms, combinatorial optimization, massively parallel computing, mathematical support for molecular biology, logic and algorithms, networks, discrete probability, massive data sets, DNA computing, large-scale discrete optimization, computational intractability, next generation networks, and computational biology. Future topics include data mining, computational information theory and coding, and computational geometry and applications.

Eagleton Institute of Politics (EIP)

191 Ryders Lane, Douglass Campus
New Brunswick, NJ 08901-8557
Telephone: 732/932-9384; Fax: 732/932-6778
http://www.eagleton.rutgers.edu
Ruth B. Mandel, *Director*

The Eagleton Institute of Politics (EIP) explores state and national politics through research, education, and public service. It also links the study of politics with its day-to-day practice. The institute focuses on how contemporary political systems work, how they change, and how they might work better. Eagleton's faculty, centers, and programs specialize in the study of state legislatures; public opinion polling and survey research; women's participation in politics; race and politics; campaigns, elections, and political parties; civic education and political engagement; and New Jersey politics. The institute includes the Center for American Women and Politics (CAWP) and the Center for Public Interest Polling (CPIP), both established in the early 1970s. For Rutgers graduate and undergraduate students, Eagleton offers a range of education programs, including an undergraduate certificate, graduate fellowships, research assistantships and internships, and opportunities to interact with political practitioners. The institute also convenes conferences and other forums for the general public. In addition, Eagleton undertakes projects to enhance political understanding and involvement, often in collaboration with politicians, government agencies, the media, nonprofit groups, and other academic institutions.

Thomas A. Edison Papers

16 Seminary Place, College Avenue Campus
New Brunswick, NJ 08901-1108
Telephone: 732/932-8511; Fax: 732/932-7554
taep@rci.rutgers.edu
http://edison.rutgers.edu
Paul B. Israel, *Director*

The Thomas A. Edison Papers is an institute devoted to the selective publication of the more than five million pages of notebooks, correspondence, patent materials, and legal records of Thomas A. Edison and his associates. The Edison Papers is cosponsored by Rutgers, The State University of New Jersey, the National Park Service, the New Jersey Historical Commission, and the Smithsonian Institution. Ten full-time faculty members associated with the institute do research on Edison and also a broad range of historical issues from the 19th and 20th centuries.

Environmental and Occupational Health Sciences Institute (EOHSI)

170 Frelinghuysen Road, Busch Campus
Piscataway, NJ 08854-8020
Telephone: 732/445-0200; Fax: 732/445-0131
Deborah Cory-Siechta, *Director*
Herbert Lowndes, *Associate Director*

The Environmental and Occupational Health Sciences Institute (EOHSI) is sponsored jointly by Rutgers, The State University of New Jersey, and the University of Medicine and Dentistry of New Jersey–Robert Wood Johnson Medical School. The institute houses a select group of scientists, physicians, educators, and policy researchers who focus on the serious health effects of environmental pollutants. Institute members investigate ways in which people are exposed to chemicals, study how chemicals react in the body, educate the public about risks from chemical exposure, and help formulate policies to protect human health. EOHSI is comprised of six divisions: toxicology, public education and risk communication, occupational health, exposure measurement and assessment, environmental health, and environmental policy. In 1988, EOHSI became the site of the first National Institutes of Health (NIH) center of excellence in New Jersey, one of only 20 such centers funded by NIH to facilitate multidisciplinary research on health problems posed by environmental exposures.

Fiber Optic Materials Research Program (FOMRP)

607 Taylor Road, Busch Campus
Piscataway, NJ 08854-8065
Telephone: 732/445-4729; Fax: 732/445-4545
sigel@alumina.rutgers.edu
George H. Sigel, Jr., *Director*

The Fiber Optic Materials Research Program (FOMRP) conducts various research projects ranging from the synthesis of new optical materials by chemical vapor deposition to advanced optical signal transmission and processing. It emphasizes research that focuses on future and advanced applications of optical fibers, particularly those that extend beyond telecommunications. Key projects include research on fiber optics for biomedical applications, design and fabrication of fiber optic sensors, fabrication of fiber optic lasers and optical amplifiers, and the development of infrared transmitting fibers based on halide and chalcogenide glasses as well as crystals and hollow waveguides. The FOMRP seeks to conduct generic research on a cooperative basis with industry and government and to provide a mechanism for technology transfer of its activities.

Institute for Health, Health Care Policy, and Aging Research (IHHCPAR)

30 College Avenue, College Avenue Campus
New Brunswick, NJ 08901-1293
Telephone: 732/932-8413; Fax: 732/932-6872
David Mechanic, *Director*

The Institute for Health, Health Care Policy, and Aging Research (IHHCPAR) was established to consolidate and focus the resources of the university on critical health and aging issues facing the nation. It facilitates collaboration among scholars who represent many disciplines, providing them with opportunities to pool their knowledge and expertise in examining multifaceted health problems.

The institute has three units: its division on health, health policy, and aging; its Center for Research on the Organization and Financing of Care for the Severely Mentally Ill; and the Center for State Health Policy, which examines critical state and regional health-policy issues. Each division of the institute provides research and training opportunities to predoctoral students enrolled in degree-granting programs elsewhere in the university, to fellows enrolled in the institute's postdoctoral program, and to undergraduates. Although the institute has broad scope, it focuses its research efforts in areas where it has analytic strength and where it can build on the excellence of academic departments and professional schools at the university.

Rutgers Center for Historical Analysis (RCHA)

88 College Avenue, College Avenue Campus
New Brunswick, NJ 08901-8542
Telephone: 732/932-8701; Fax: 732/932-8708
Zivi Galili, *Director*

The Rutgers Center for Historical Analysis (RCHA) is a multidisciplinary research center and an affiliate of the history department at Rutgers–New Brunswick. It provides a setting to discuss issues of broad contemporary relevance in historical perspective. Organizing its annual activities around major themes of inquiry or research projects, the center each year welcomes visiting senior and postdoctoral fellows chosen through an open, international competition, along with several faculty and graduate fellows from Rutgers. In addition to weekly seminars, the center hosts a variety of public conferences and related cultural events, sponsors the Institute for High School Teachers, and houses the *Journal of the History of Ideas.*

IEEE History Center

39 Union Street, College Avenue Campus
New Brunswick, NJ 08901-8538
Telephone: 732/932-1066; Fax: 732/932-1193
Michael N. Geselowitz, *Director*

The IEEE History Center is a joint venture between Rutgers, The State University of New Jersey, and the Institute of Electrical and Electronics Engineers, Inc. The center undertakes research, public outreach, and archival work in all aspects of the history of electrical, electronic, and computing technology and their social, political, and cultural contexts. IEEE also awards an annual fellowship and historical paper prize.

Institute of Marine and Coastal Sciences (IMCS)

71 Dudley Road, Cook Campus
New Brunswick, NJ 08901-8521
Telephone: 732/932-6555; Fax: 732/932-8578
J. Frederick Grassle, *Director*

The Institute of Marine and Coastal Sciences (IMCS) conducts and integrates research efforts on estuarine, marine, and coastal processes for New Jersey and the surrounding region. Current research themes include establishment of Long-Term Ecosystem Observatories (LEOs), fish and shellfish biology and ecology, estuarine and nearshore ecology, biogeochemistry, aquaculture, genetics of marine populations, coastal physical oceanography, coastal geology, hydrothermal vent research, pinelands ecology, and deep-sea research. The institute features advanced field and

laboratory facilities such as a real-time satellite remote sensing laboratory; high-performance computers; a coastal observation network; and annular and racetrack flumes for studies of interactions among flow, sediment geochemistry and transport, and organism behavior and growth. IMCS faculty advise students in oceanography, environmental sciences, ecology and evolution, geology, and several areas of engineering.

Center for Nanostructured Materials (CNM)

School of Engineering
98 Brett Road, Busch Campus
Piscataway, NJ 08854-8058
Telephone: 732/445-2888; Fax: 732/445-3229
Thomas Tsakalakos, *Director*
William E. Mayo, *Codirector*

The Center for Nanostructured Materials (CNM) is jointly supported by the New Jersey Commission on Science and Technology, Rutgers, The State University of New Jersey, and several industry members. CNM's mission is to support forefront research in advanced materials areas and to promote industry-university interactions. Research areas include chemical and physical synthesis of nanostructured materials, ultrafine powder thin-film technology, and advanced characterization. Equipment at CNM is consolidated into six major facilities: chemical synthesis, physical synthesis, X ray, ion beam, electron microscopy, and modeling and computer simulations.

Center for Packaging Science and Engineering

137 Winchester Road, Busch Campus
Piscataway, NJ 08854-8029
Telephone: 732/445-3224; Fax: 732/445-5636
James D. Idol, *Director*

The Center for Packaging Science and Engineering consists of a research division with four laboratories and an information center for packaging and related fields. The major research thrusts of the center are in packaging science and technologies, covering food and beverage packaging; pharmaceutical, medical, and health care packaging; industrial hard and soft goods packaging; and materials science related to packaging processes and products. The Distribution Packaging Laboratory evaluates package performance in the distribution environments. The Permeation/Leakage Laboratory studies barrier properties of packaging materials. The Materials/Package Laboratory studies mechanical, physical, and chemical properties and performance of packaging materials. The Packaging Machinery Laboratory studies packaging machinery design, operation, and interactions of packaging machinery and packaging materials.

Institute for Research on Women (IRW)

160 Ryders Lane, Douglass Campus
New Brunswick, NJ 08901-8555
Telephone: 732/932-9072; Fax: 732/932-0861
Dorothy Sue Cobble, *Director*

Founded in 1976 to provide an exchange of ideas and information among scholars on the New Brunswick campuses, the IRW has taken a leading role regionally and nationally in enabling and disseminating new research and writing on women and gender. The institute brings together several hundred university faculty members and graduate students who are working on gender-related subjects; organizes interdisciplinary lectures, seminars, and conferences; and hosts visiting scholars in a range of disciplines. The institute sponsors a weekly graduate student/faculty seminar. With the financial support of the Rockefeller Foundation, it is the site of a project on gender, race, and ethnicity. The IRW also sponsors an annual graduate student conference.

Laboratory for Surface Modification (LSM)

Serin Physics Laboratory
136 Frelinghuysen Road, Busch Campus
Piscataway, NJ 08854-8019
Telephone: 732/445-5185; Fax: 732/445-4991
Theodore E. Madey, *Director*

The Laboratory for Surface Modification (LSM) provides a focus for research in basic and applied studies of high-technology surfaces and interfaces. Its activities involve multidisciplinary research in the disciplines of physics, chemistry, ceramics, materials science, and electrical engineering. Surface modification encompasses a broad spectrum of phenomena that occur at the atomic level on the surface of solids, and advances in this technology have a fundamental impact on the fields of telecommunications, petroleum, superconductivity, computer science, minerals, and chemicals. Research is supported with extensive, state-of-the-art, ultrahigh vacuum instrumentation, electronics, and computational facilities. In addition, the laboratory operates a 1.7 MV Tandetron accelerator, complete with Rutherford backscattering and ion channeling capabilities. Another laboratory facility is a Kratos XSAM Surface Analysis system containing X-ray photoelectron spectroscopy, Auger electron spectroscopy, and ion-scattering spectroscopy.

Laboratory of Vision Research (LVR)

Psychology Building Addition
152 Frelinghuysen Road, Busch Campus
Piscataway, NJ 08854-8020
Telephone: 732/445-6660; Fax: 732/445-6715
Thomas Papathomas, *Associate Director*

The Laboratory of Vision Research (LVR) has three major objectives: to conduct advanced interdisciplinary research in vision, to establish undergraduate and graduate courses in visual perception and related areas, and to serve as a consulting body to New Jersey and national institutions. Research is focused on early vision, such as texture, stereoscopic depth, and motion perception and some higher processing states, such as the role of focal attention in visual tasks. Practical applications of research conducted in the laboratory include the diagnosis and prevention of stereo blindness, invention of new ways to match large databases to the heuristics of the human observer, and the development of image-compression techniques based on the properties of the human visual system.

Transliteratures Project

107B Ruth Adams Building, Douglass Campus
Telephone: 732/932-3601
eisenzwe@rci.rutgers.edu
Uri Eisenweig, *Director*

In response to the new cultural challenges posed to American institutions of higher learning by the growing globalization of societies, the Transliteratures project is dedicated to the promotion, at Rutgers, of foreign literatures and cultures in a manner that transcends the dual relation of these cultures and literatures to our own, and takes into account the interaction between these foreign cultures themselves. The project helps graduate students in foreign literature programs better situate the culture in which they specialize in an international context, through various initiatives taken at three levels: curricular, extracurricular, and with respect to student support.

On the curricular level, Transliteratures sponsors two major initiatives. One is a recently implemented graduate school requirement that all graduate students in foreign literature and language programs take at least two seminars in a foreign literature program other than their own. To make this requirement possible, all foreign literature programs have developed a number of seminars taught on English, with texts available in translation. The other initiative is the creation of intensive summer language reading classes open exclusively to graduate students. The classes usually offered are in French, German, Italian, Latin, Portuguese, and Spanish.

On the extracurricular level, Transliteratures provides support to a wide range of lectures and conferences organized by the foreign literature programs, and that are of interest to students and faculty from neighboring programs.

Finally, the Transliteratures project provides support to graduate students. Special fellowships that carry a stipend of $18,000 for a five-year period, have been created to attract outstanding graduate applicants with advanced knowledge in at least two of the foreign languages taught at the graduate level at Rutgers. Qualifying students are required to take two regular seminars in a foreign literature other than the one they specialize in, with the texts read in the original language. One fellowship a year is available for each one of the six programs involved: classics, comparative literature, French, German, Italian, and Spanish. Also, Transliteratures provides small research- and conference-related travel grants to students.

Center for Urban Policy Research (CUPR)

33 Livingston Avenue, Suite 400
New Brunswick, NJ 08901-1982
Telephone: 732/932-3134; Fax: 732/932-2363
Robert W. Burchell, *Codirector*
David Listokin, *Codirector*

The Center for Urban Policy Research (CUPR) specializes in housing, land use, economic development, and urban-poverty issues. It is concerned with both the academic quality of urban research and the practical application of research results to policy formulation and implementation. CUPR conducts research for federal agencies, major private foundations, and state and local governments. Its faculty hold joint appointments in the sociology, economics, geography, urban planning and policy development, and urban studies departments. Major projects include housing studies for the U.S. Department of Housing and Urban Development; a Community Outreach Partnership Center in Newark (also for the U.S. Department of Housing and Urban Development); an evaluation of New Brunswick's Hope VI program; program evaluations for the U.S. Economic Development Administration; costs of sprawl studies for several states; and costs and benefits of historic preservation for federal and state agencies and major foundations. In other work, CUPR's Rutgers Economic Advisory Service (R/ECON) prepares economic forecasts and analyses for businesses and governments, and its Project Community provides direct services and technical assistance to community-based organizations and nonprofit groups engaged in neighborhood revitalization. The center publishes a quarterly newsletter; monographs and working papers are published through the CUPR Press.

Waksman Institute of Microbiology (WIM)

190 Frelinghuysen Road, Busch Campus
Piscataway, NJ 08854-8020
Telephone: 732/445-3060; Fax: 732/445-5735
Joachim Messing, *Director*

The Waksman Institute of Microbiology (WIM) is an internationally recognized center of excellence in molecular genetics. Using microbe, plant, and animal genetic models, members of the institute are studying gene expression and signal transduction controlled by a number of environmental and developmental stimuli. A new focus on structural and computational biology complements these areas of interest. Nineteen laboratories arranged around four groups (microbial, plant, and developmental genetics and structural biology) equipped with state-of-the-art equipment provide graduate students the opportunity to learn the latest techniques in molecular genetics. In addition, the Waksman Institute houses the Molecular Biology Computing Lab.

Administration

Officers

Holly M. Smith, *Ph.D., Professor of Philosophy, Dean of the Faculty of Arts and Sciences and Dean of the Graduate School–New Brunswick*

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Evelyn S. Erenrich, *Ph.D., Assistant Dean for Recruitment and Retention of the Graduate School–New Brunswick*

David S. Pickens, *M.A., Assistant Dean for Publications and Special Projects of the Graduate School–New Brunswick*

Lisa Estler, *Business Manager*

Teresa Delcorso, *Program Development Specialist in External Funding*

Alexandria Bachmann, *Administrator for Academic Support and Student Services*

Barbara Sirman, *Administrator for Degree Certification*

Executive Council of the Graduate School– New Brunswick 2003–2004

Dates in parentheses indicate expiration of term of membership.

The dean, vice dean, and associate deans of the Graduate School– New Brunswick

Susan Albin, *Professor of Industrial and Systems Engineering (2004) ＊*

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Leslie Small, *Professor of Agricultural Economics (2005)*

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Student Representatives

Carrie Preston

Dennis Whitcomb

Graduate School–New Brunswick Representatives to the University Senate 2003–2004

Dates in parentheses indicate expiration of term of membership.

Haim Baruh, *Professor of Mechanical and Aerospace Engineering (2004)*

Daren Cerulo, *Associate Professor of Sociology (2005)*

Martha Cotter, *Professor of Chemistry (2006)*

Lee Cronk, *Associate Professor of Anthropology (2005)*

Monica Driscoll, *Professor of Molecular Biology and Biochemistry (2004)*

David Merritt, *Professor of Physics and Astronomy (2006)*

Mark Plummer, *Associate Professor of Cell Biology and Neurosciences (2004)*

Michael Sukhdeo, *Associate Professor of Ecology and Evolution, and Natural Resources (2005)*

Barbara Turpin, *Associate Professor of Environmental Science (2006)*

New Brunswick Faculty Council 2003–2004

Carolyn Williams, *Associate Professor of English (2004)*

Charles M. Glashausser, *Professor of Physics and Astronomy (2006)*

Administrative Offices

Office of the Graduate School–New Brunswick, 25 Bishop Place, College Avenue Campus (732/932-7034)

Office of Graduate and Professional Admissions, 18 Bishop Place, College Avenue Campus (732/932-7711)

Cashier, Records Hall, College Avenue Campus (732/932-7044)

Office of the Graduate Registrar, Administrative Services Building, Busch Campus (732/445-2104, 3556)

Cashier, Administrative Services Building, Busch Campus (732/445-3008)

＊ Appointed by the dean.

Governance of the University

State of New Jersey

James E. McGreevey, *Governor of the State*

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Divisions of the University

ACADEMIC DIVISIONS

Rutgers, The State University of New Jersey, provides educational and research services throughout the state on campuses located in Camden, Newark, and New Brunswick. The principal university center is located in New Brunswick, where Rutgers originated two centuries ago.

Camden

Camden offers programs at three undergraduate colleges and at three graduate schools. With an enrollment of 5,200 students, it offers exceptional educational opportunities in addition to providing the advantages and resources associated with a major state university.

Faculty of Arts and Sciences–Camden
Margaret Marsh, *Ph.D., Dean*

Established in 1983 as a result of academic reorganization of the Camden campus, the Faculty of Arts and Sciences–Camden offers academic programs for undergraduate and graduate work in 23 arts and sciences disciplines and in a variety of interdisciplinary areas.

School of Business–Camden
Milton Leontiades, *Ph.D., Dean*

Established in 1988, the School of Business–Camden sets major requirements and teaches all courses leading to the bachelor of science degree in the professional areas of accounting and management. The School of Business also sets the major requirements and teaches all courses leading to a master of business administration degree.

Camden College of Arts and Sciences
Margaret Marsh, *Ph.D., Dean*

A coeducational, liberal arts college, CCAS is the successor institution to the College of South Jersey, which was established in 1927 and became part of the state university in 1950.

University College–Camden
Margaret Marsh, *Ph.D., Dean*

University College–Camden is an evening college of liberal arts and professional studies serving part-time students since 1950.

Graduate School–Camden
Margaret Marsh, *Ph.D., Dean*

Graduate programs in the liberal arts were started in Camden in 1971 under the jurisdiction of the Graduate School–New Brunswick. The Graduate School–Camden was established as an autonomous unit in 1981.

School of Law–Camden
Rayman L. Solomon, *J.D., Ph.D., Dean*

Founded in 1926, the School of Law–Camden joined the university in 1950 as the South Jersey division of the School of Law–Newark. It became an independent unit of the university in 1967. The law school offers a curriculum leading to the degree of juris doctor, including advanced study in special areas.

Summer Session–Camden
Thomas Venables, *Ed.D.*

The Summer Session, begun in 1913 and established as a division of the university in 1960, offers a wide variety of graduate and undergraduate courses during three sessions in the summer months.

Newark

Newark offers programs at three undergraduate colleges and at four graduate schools. With an enrollment of approximately 10,300 students, it offers strong academic programs, excellent facilities, and an outstanding faculty.

Faculty of Arts and Sciences–Newark
Edward G. Kirby, *Ph.D., Dean*

The Faculty of Arts and Sciences–Newark was established in 1985 to expand and strengthen the instructional program for undergraduate students at the Newark campus. The combined faculties of Newark College of Arts and Sciences and University College–Newark offer courses and academic programs in more than 60 subject areas.

Newark College of Arts and Sciences
Edward G. Kirby, *Ph.D., Dean*

Founded in 1930 as Dana College, this undergraduate, coeducational, liberal arts college became part of Rutgers when the University of Newark was integrated into the state university in 1946.

College of Nursing
Felissa R. Lashley, *Ph.D., Dean*

The College of Nursing was established in 1956 as an expansion of the university's offerings in the former School of Nursing of the Newark College of Arts and Sciences. Its graduate program is conducted through the Graduate School–Newark.

University College–Newark
Edward G. Kirby, *Ph.D., Dean*

University College–Newark is an evening and weekend college of liberal arts and professional studies serving part-time students since 1934. Within the context of the liberal arts tradition, University College students are offered a full range of courses and curricula, including programs in business and preparation for the professions leading to the degrees of bachelor of arts and bachelor of science.

Rutgers Business School–Newark and New Brunswick
Howard Tuckman, *Ph.D., Dean*

Established in 1993 as the Faculty of Management, Rutgers Business School offers undergraduate and graduate programs on or through the university's Newark and New Brunswick campuses. Rutgers Business School: Undergraduate–Newark is a four-year undergraduate school. It offers the bachelor of science degree jointly with either the Newark College of Arts and Sciences or University College–Newark. Degree programs are available in accounting, finance, management, and marketing. Rutgers Business School: Undergraduate–New Brunswick is a two-year, upper-division school offering programs in accounting, finance, management, management science and information systems, and marketing. The school admits students from Douglass, Livingston, Rutgers, and University Colleges in their junior year. The bachelor of science degree is awarded jointly by the business school and the undergraduate college the student attended. Rutgers Business School: Graduate Programs–Newark and New Brunswick dates from the Seth Boyden School of Business, which was founded in 1929 and incorporated into Rutgers in 1946. The school offers the master of business administration, an M.B.A. degree in professional accounting, a master of accountancy in taxation, a master of accountancy in governmental accounting, a master of accountancy in financial accounting, a master of quantitative finance, and a variety of dual degrees. The Ph.D. degree in management is offered jointly by the Graduate School–Newark and the New Jersey Institute of Technology.

Graduate School–Newark
Steven J. Diner, *Ph.D., Dean*

The Graduate School–Newark was established as a separate instructional division of the university with degree-granting authority in 1976.

School of Criminal Justice
Leslie W. Kennedy, *Ph.D., Dean*

The School of Criminal Justice, which opened in 1974, offers a graduate program that provides students with a sound foundation for work in teaching, research, or criminal justice management. The master of arts degree is offered through the school, and the Ph.D. degree is offered in conjunction with the Graduate School–Newark.

School of Law–Newark
Stuart L. Deutsch, *J.D., Dean*

The university's graduate programs in law originated in other institutions. The New Jersey School of Law, founded in 1908, and the Mercer Beasley School of Law, founded in 1926, merged in 1936 to become the University of Newark School of Law, which became part of Rutgers in 1946.

Summer Session–Newark

The Summer Session, begun in 1913 and established as a division of the university in 1960, offers a wide variety of graduate and undergraduate courses during three sessions in the summer months.

New Brunswick

The New Brunswick campus is the largest and most diversified of the university's three campuses, with 16 academic units, 1,800 faculty, and 36,000 students enrolled in undergraduate and graduate programs.

Faculty of Arts and Sciences–New Brunswick
Holly M. Smith, *Ph.D., Executive Dean*

Established in 1981 as a result of academic reorganization of the New Brunswick campus, the Faculty of Arts and Sciences–New Brunswick teaches all arts and science courses for undergraduate and graduate students in degree-granting units and sets the major requirements for all arts and science majors. Organized into disciplines and departments, it offers 44 undergraduate major programs and 29 graduate programs, which are administered by the Graduate School–New Brunswick.

Douglass College
Carmen Twillie Ambar, *J.D., Dean*

Founded in 1918 as the New Jersey College for Women, Douglass is the largest women's college in the nation. While maintaining rigorous standards of instruction in the fundamental disciplines of the liberal arts, Douglass supports and develops programs that link major courses of study to future careers. The college also implements special programs as well as independent activities designed to help women students develop the qualities required for achievement in any field of endeavor.

Livingston College
Arnold Hyndman, *Ph.D., Dean*

Livingston College opened in 1969 as a coeducational institution dedicated to serving a diverse student body reflecting the racial, ethnic, and socioeconomic composition of today's society. As a college of the liberal arts and professions, Livingston is committed to a multidisciplinary program that brings together a diverse group of students, faculty, and staff in a cosmopolitan community dedicated to learning.

Rutgers College
Carl Kirschner, *Ph.D., Dean*

Rutgers College was chartered in 1766 and is the original nucleus around which the university developed. Formerly an undergraduate college for men, it is now coeducational. Dedicated to the promotion of excellence in undergraduate education, Rutgers College provides its students with clear guidelines in the pursuit of a liberal arts education.

University College–New Brunswick
Emmet A. Dennis, *Ph.D., Dean*

University College–New Brunswick is an evening college of liberal arts and professional studies serving part-time students since 1934. Within the context of the liberal arts tradition, University College–New Brunswick students are offered a full range of courses and curricula, including programs in business and preparation for the professions leading to the degrees of bachelor of arts and bachelor of science.

Cook College

Keith R. Cooper, *Ph.D., Acting Dean*

A coeducational and residential college, Cook offers under-graduate programs in various applied disciplines with an emphasis on environmental, agricultural, food, and marine sciences. Formerly the College of Agriculture and later the College of Agriculture and Environmental Science, Cook College adopted its present name in 1973. Graduate programs are offered through the Graduate School–New Brunswick.

Ernest Mario School of Pharmacy

John L. Colaizzi, *Ph.D., Dean*

First organized in 1892 and incorporated into the state uni-versity in 1927, the Ernest Mario School of Pharmacy offers a six-year professional program leading to the doctor of pharmacy (Pharm.D.) degree and a graduate program offering a post-B.S. Pharm.D. degree (both traditional two-year and nontraditional). Other graduate programs leading to advanced degrees through the Graduate School–New Brunswick are available. In addition, the school sponsors a continuing education program for the benefit of practicing pharmacists throughout the state.

Mason Gross School of the Arts

George B. Stauffer, *Ph.D., Dean*

This branch of Rutgers opened in July 1976. The school grants both undergraduate and graduate degrees. Formed to provide an education in the arts of the highest profes-sional caliber, the school offers an M.F.A. degree in visual arts and theater arts; D.M.A., A.Dpl., M.M., and B.Mus. degrees in music; and a B.F.A. degree in visual arts, dance, and theater arts.

Rutgers Business School–Newark and New Brunswick

Howard Tuckman, *Ph.D., Dean*

Established in 1993 as the Faculty of Management, Rutgers Business School offers undergraduate and graduate programs on or through the university's Newark and New Brunswick campuses. Rutgers Business School: Undergraduate–Newark is a four-year undergraduate school. It offers the bachelor of science degree jointly with either the Newark College of Arts and Sciences or University College–Newark. Degree programs are available in accounting, finance, management, and marketing. Rutgers Business School: Undergraduate–New Brunswick is a two-year, upper-division school offering programs in accounting, finance, management, management science and information systems, and marketing. The school admits students from Douglass, Livingston, Rutgers, and University Colleges in their junior year. The bachelor of sci-ence degree is awarded jointly by the business school and the undergraduate college the student attended. Rutgers Business School: Graduate Programs–Newark and New Brunswick dates from the Seth Boyden School of Business, which was founded in 1929 and incorporated into Rutgers in 1946. The school offers the master of business adminis-tration, an M.B.A. degree in professional accounting, a mas-ter of accountancy in taxation, a master of accountancy in governmental accounting, a master of accountancy in finan-cial accounting, a master of quantitative finance, and a vari-ety of dual degrees. The Ph.D. degree in management is offered jointly by the Graduate School–Newark and the New Jersey Institute of Technology.

School of Communication, Information and Library Studies

Gustav Friedrich, *Ph.D., Dean*

This school was formed in 1982 by a merger of two schools to provide academic programs that focus on various facets of communication and information science. The school offers undergraduate programs of study in communication, and journalism and mass media. Students are admitted to the school in their junior year from the five residential undergraduate colleges in New Brunswick: Cook, Douglass, Livingston, Rutgers, and University Colleges. Bachelor of arts degrees are awarded jointly by the School of Communication, Information and Library Studies and the undergraduate college. At the graduate level, programs are offered that lead to the degree of master of library and information science, the master of communication and information studies, and, jointly with the Graduate School–New Brunswick, the doctor of philosophy degree. Courses for in-service librarians also are provided.

School of Engineering

Michael T. Klein, *Sc.D., Dean*

Instruction in engineering began at Rutgers in 1864 when New Jersey designated Rutgers College to be the State College for the Benefit of Agriculture and Mechanic Arts. The College of Engineering became a separate unit in 1914 and was renamed the School of Engineering in 1999. The school is dedicated to the sound technical and general edu-cation of the student. It offers a bachelor of science degree in seven disciplines as well as a curriculum in applied sciences. Its graduate programs are conducted through the Graduate School–New Brunswick.

Edward J. Bloustein School of Planning and Public Policy

James W. Hughes, *Ph.D., Dean*

Founded in 1992, the Edward J. Bloustein School of Planning and Public Policy provides focus for all of Rutgers' programs of instruction, research, and service in planning and public policy. The school offers undergradu-ate programs in urban studies and public health, each lead-ing to the baccalaureate degree. On the graduate level, the school confers master of city and regional planning, master of city and regional studies, master of public affairs and politics, master of public policy, master of public health, and doctor of public health degrees; the latter two degrees are offered jointly with the University of Medicine and Dentistry of New Jersey–School of Public Health. A dual-degree program in public health and applied psychology leading to the master of public health and doctor of psy-chology degrees is offered with the Graduate School of Applied and Professional Psychology. A program also is offered that leads to the doctor of philosophy degree in urban planning and policy development; this degree is con-ferred by the Graduate School–New Brunswick. In addi-tion, the school offers joint-degree programs with Rutgers' two law schools, with the Rutgers Business School: Graduate Programs–Newark and New Brunswick, and with the Graduate School–New Brunswick.

School of Management and Labor Relations

Barbara A. Lee, *Ph.D., J.D., Dean*

The School of Management and Labor Relations, formed in 1994, provides undergraduate instruction in labor

studies and employment relations. At the graduate level, programs are offered that lead to the degrees of master in human resource management, master in labor and employment relations, and doctor of philosophy in industrial relations and human resources.

Graduate School–New Brunswick
Holly M. Smith, *Ph.D., Dean*

Graduate programs in the arts and sciences have been offered since 1876. The Graduate School–New Brunswick awards advanced degrees in more than 60 disciplines and is responsible for all doctor of philosophy degrees at Rutgers–New Brunswick. The faculty is drawn from virtually all academic divisions of the university.

Graduate School of Applied and Professional Psychology
Stanley B. Messer, *Ph.D., Dean*

GSAPP was established in 1974 to train direct-service psychologists who have a special commitment to community involvement. It offers the doctor of psychology (Psy.D.) degree in professional psychology with specializations in the areas of clinical psychology, school psychology, and organizational psychology. GSAPP also awards the master of psychology (Psy.M.) degree *en passant* to the doctorate; the Psy.M. is not offered as a terminal degree.

Graduate School of Education
Richard DeLisi, *Ph.D., Acting Dean*

Courses in education were first offered by Rutgers College in the late 19th century. A separate school offering its own curricula was organized in 1924. GSE offers programs leading to the degrees of master of education, specialist in education, and doctor of education.

School of Social Work
Mary E. Davidson, *Ph.D., Dean*

Established in 1954 to prepare students for professional social work practice, SSW offers a two-year graduate curriculum leading to the master of social work degree. Jointly with the Graduate School–New Brunswick, it offers a program leading to the doctor of philosophy degree, and its faculty also teaches an undergraduate social work program.

Summer Session–New Brunswick
Thomas A. Kujawski, *Ed.M.*

The Summer Session, begun in 1913 and established as a division of the university in 1960, offers a wide variety of graduate and undergraduate courses during three sessions in the summer months.

ACADEMIC CENTERS, BUREAUS, AND INSTITUTES

Academic Foundations Center. Conklin Hall, Newark Campus

Advanced Food Technology, Center for. Nabisco Institute for Advanced Food Technology, Cook Campus

Advanced Information Processing, Center for. CoRE Building, Busch Campus

Agricultural Experiment Station, New Jersey. Martin Hall, Cook Campus

Alcohol Studies, Center of. Smithers Hall, Busch Campus

American Women and Politics, Center for. Wood Lawn, Douglass Campus

Art Museum, Jane Voorhees Zimmerli. College Avenue Campus

Biological Research, Bureau of. Nelson Biology Laboratories, Busch Campus

Biostatistics, Institute of. Hill Center, Busch Campus

Biotechnology Center for Agriculture and the Environment. Cook Campus

Ceramic Research, Malcolm G. McLaren Center for. 607 Taylor Road, Busch Campus

Coastal and Environmental Studies, Center for. Doolittle Hall, Busch Campus

Computer Science Research, Laboratory for. Hill Center, Busch Campus

Controlled Drug-Delivery Research Center. Pharmacy Building, Busch Campus

Crime Prevention Studies, Center for. Center for Law and Justice, Newark Campus

Criminological Research, Institute for. Lucy Stone Hall, Livingston Campus

Critical Analysis of Contemporary Culture, Center for the. 8 Bishop Place, College Avenue Campus

Discrete Mathematics and Theoretical Computer Science, Center for. CoRE Building, Busch Campus

Eagleton Institute of Politics. Wood Lawn, Douglass Campus

Economic Research, Bureau of. New Jersey Hall, College Avenue Campus

Edison Papers, Thomas A. 16 Seminary Place, College Avenue Campus

Education Law and Policy, Institute for. Center for Law and Justice, Newark Campus

Engineered Materials, Institute for. Engineering Building, Busch Campus

Engineering Research, Bureau of. Engineering Building, Busch Campus

Fiber Optic Materials Research Program. 607 Taylor Road, Busch Campus

Fisheries and Aquaculture Technology Extension Center. Martin Hall, Cook Campus

Global Strategic Human Resource Management, Center for. School of Management and Labor Relations, 94 Rockafeller Road, Livingston Campus

Government Services, Center for. Edward J. Bloustein School of Planning and Public Policy, 33 Livingston Avenue, College Avenue Campus

Health, Health Care Policy, and Aging Research, Institute for. 30 College Avenue, College Avenue Campus

Historical Analysis, Rutgers Center for. 88 College Avenue, College Avenue Campus

Human Evolutionary Studies, Center for. 131 George Street, College Avenue Campus

International Business Education, Center for. Janice H. Levin Building, Livingston Campus

International Conflict Resolution and Peace Studies, Center for. Hickman Hall, Douglass Campus

International Faculty and Student Services, Center for. 180 College Avenue, College Avenue Campus

Jazz Studies, Institute of. Dana Library, Newark Campus

Jewish Life, Center for the Study of. 12 College Avenue, College Avenue Campus

Journalism Resources Institute. 185 College Avenue, College Avenue Campus

Marine and Coastal Sciences, Institute of. 71 Dudley Road, Cook Campus

Materials Synthesis, Center for. Engineering Building, Busch Campus

Mathematical Sciences Research, Center for. Hill Center, Busch Campus

Mathematics, Science, and Computer Education, Center for. Science and Engineering Resource Center, Busch Campus

Metropolitan Studies, Joseph C. Cornwall Center for. Smith Hall, Newark Campus

Molecular and Behavioral Neuroscience, Center for. Aidekman Center, Newark Campus

Negotiation and Conflict Resolution, Center for. Edward J. Bloustein School of Planning and Public Policy, 33 Livingston Avenue, College Avenue Campus

Neighborhood and Brownfields Redevelopment, National Center for. Edward J. Bloustein School of Planning and Public Policy, 33 Livingston Avenue, College Avenue Campus

Operations Research, Center for. Hill Center, Busch Campus

Packaging Science and Engineering, Center for. Engineering Building, Busch Campus

Physics Research, Bureau of. Serin Physics Laboratories, Busch Campus

Rutgers Cooperative Extension. Martin Hall, Cook Campus

Surface Modification, Laboratory for. Serin Physics Laboratories, Busch Campus

Transportation Center, Alan M. Voorhees. Edward J. Bloustein School of Planning and Public Policy, 33 Livingston Avenue, College Avenue Campus

Urban Policy Research, Center for. 33 Livingston Avenue, College Avenue Campus

Waksman Institute of Microbiology. 190 Frelinghuysen Road, Busch Campus

Walt Whitman Center for the Culture and Politics of Democracy. Hickman Hall, Douglass Campus

Wireless Information Network Laboratory. Electrical Engineering Building, Busch Campus

Women, Institute for Research on. 160 Ryders Lane, Douglass Campus

Women and Work, Center for. School of Management and Labor Relations, 162 Ryders Lane, Douglass Campus

Women's Leadership, Institute for. 162 Ryders Lane, Douglass Campus

Workforce Development, John J. Heldrich Center for. Edward J. Bloustein School of Planning and Public Policy, 33 Livingston Avenue, College Avenue Campus

Workplace Transformation, Center for. School of Management and Labor Relations, Labor Education Center, 50 Labor Center Way, Cook Campus

Centers Operated Jointly

Biotechnology and Medicine, Center for Advanced.

Environmental and Occupational Health Sciences Institute.

Hazardous Substance Management Research Center.

UNIVERSITY LIBRARY SYSTEM

Alcohol Studies Library. Smithers Hall, Busch Campus

Annex. Annex Building, Busch Campus

Archibald Stevens Alexander Library. 169 College Avenue, College Avenue Campus

Art Library. Hamilton Street, College Avenue Campus

Blanche and Irving Laurie Music Library. Douglass Library, Chapel Drive and George Street, Douglass Campus

Chemistry Library. Wright Chemistry Laboratory Building, Busch Campus

Chrysler Herbarium Library. Nelson Biology Laboratories, Busch Campus

Criminal Justice Library. Center for Law and Justice, 123 Washington Street, Newark Campus

East Asian Library. Alexander Library, College Avenue Campus

Institute of Jazz Studies Library. John Cotton Dana Library, Newark Campus

John Cotton Dana Library. 185 University Avenue, Newark Campus

Kilmer Area Library. Avenue E, Livingston Campus

Library of Science and Medicine. Bevier Road, Busch Campus

Mabel Smith Douglass Library. Chapel Drive and George Street, Douglass Campus

Mathematical Sciences Library. Hill Center, Busch Campus

Media Services. Kilmer Area Library, Livingston Campus

Paul Robeson Library. 300 North Fourth Street, Camden Campus

Physics Library. Serin Physics Laboratories, Busch Campus

School of Law–Camden Library. Fifth and Penn Streets, Camden Campus

School of Law–Newark Library. Center for Law and Justice, 123 Washington Street, Newark Campus

School of Management and Labor Relations Library. Ryders Lane, Cook Campus

SERC Reading Room. Science and Engineering Resource Center, Frelinghuysen Road, Busch Campus

Special Collections and University Archives. Alexander Library, College Avenue Campus

Stephen and Lucy Chang Science Library. Foran Hall, Cook Campus

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