COLLEGE OF AGRICULTURE AND LIFE SCIENCES

INTRODUCTION

College Focus

The College of Agriculture and Life Sciences offers men and women broad-based educational programs to provide them with technical, management, and leadership skills in four primary areas of focus. These areas were developed in response to the global challenges of the 21st century. They are fluid, overlapping, and interdependent and represent agriculture and life sciences at its broadest and most dynamic meaning. These four areas are:

- Land-grant, or agricultural sciences
- Applied social sciences
- Environmental sciences
- New life sciences

Faculty members challenge students with educational programs that promote problem-solving, basic and applied research, extension, and outreach. The programs are geared to the discovery and dissemination of knowledge for the purpose of advancing agriculture and food systems, health and nutrition, food security, biological sciences, education, communication, natural resources and environmental quality, and community, urban, and rural development throughout New York State, the nation, and the world.

Administration

Susan A. Henry, dean

Barbara A. Knuth, co–senior associate dean

Jan P. Nyrop, co–senior associate dean

Margaret H. Ferguson, associate dean for finance and administrative services

Michael P. Riley, associate dean for alumni affairs, development, and communications

Donald R. Viands, associate dean and director of academic programs

Mark W. Wysocki, associate director of academic programs

Jeffrey J. Doyle, director of undergraduate biology

Michael P. Hoffmann, associate dean and director of the Cornell University Agricultural Experiment Station

Susan J. Riha, director for sponsored research in the senior associate dean's office

Helene R. Dillard, associate dean and director of cooperative extension

Christopher B. Watkins, associate director of cooperative extension

Glenn J. Applebee, associate director of cooperative extension

Daniel J. Decker, director of CALS land grant affairs, senior advisor to the dean

W. Ronnie Coffman, director of international programs

James E. Haldeman, associate director of international programs

Terry W. Tucker, associate director of international programs

Alice Pell, director of Cornell International Institute for Food, Agriculture, and Development

Department Chairs

Animal science: W. Ronald Butler, 149 Morrison Hall

Applied economics and management: William H. Lesser, 154 Warren Hall

Biological and environmental engineering: Michael F. Walter, 104 Riley-Robb Hall

Biological statistics and computational biology: Martin T. Wells, 1190 Comstock Hall

Communication: Geri K. Gay, 339 Kennedy Hall

Crop and soil sciences: Stephen D. DeGloria, 232 Emerson Hall

Development sociology: Max Pfeffer, 133A Warren Hall

Earth and atmospheric sciences: Teresa E. Jordan, 2116 Snee Hall; Stephen J. Colucci, co-chair, 1116 Bradfield Hall

Ecology and evolutionary biology: Richard G. Harrison, E345 Corson Hall

Education: Arthur L. Wilson, 435 Kennedy Hall

Entomology: Jeffrey G. Scott, 6134 Comstock Hall

Food science: Joseph H. Hotchkiss, 119 Stocking Hall

Horticulture: Marvin P. Pritts, 134A Plant Science Bldg.

Landscape architecture: Peter J. Trowbridge, 446 Kennedy Hall

Microbiology: William C. Ghiorse, B76C Wing Hall

Molecular biology and genetics: Kenneth J. Kemphues, 435 Biotechnology Bldg.

Natural resources: Marianne E. Krasny, 118 Fernow Hall

Neurobiology and behavior: Thomas D. Seeley, W301 S. G. Mudd Hall

Plant biology: William L. Crepet, 221 Plant Science Bldg.

Plant breeding and genetics: Mark E. Sorrells, 241 Emerson Hall

Plant pathology: George W. Hudler, 334 Plant Science Bldg.

Statistical sciences: Martin T. Wells, 301 Malott Hall

Student Services

Office of Academic Programs

The College of Agriculture and Life Sciences (CALS) provides a variety of services for students, faculty, and alumni. The hub of these services is the Office of Academic Programs in Roberts Hall, including the director, associate director, the Admissions Office, the Career Development Office, the Counseling and Advising Office, the Multicultural and Diversity Office, and the Registrar's Office. Although most of the student services are in the Office of Academic Programs, services also are located across the college in the Office of Undergraduate Biology and in various departments. Faculty members in the College of Agriculture and Life Sciences consider advising to be an important and integral part of the undergraduate program. Each student enrolled in the college is assigned to a faculty advisor in his or her major field of study for assistance and guidance in developing a program of study, and to enhance the student's academic experience.

The Counseling and Advising Office coordinates the faculty advising program, serves as the college's central undergraduate advising office, coordinates the college international exchange programs, and offers personal counseling. Academic advising is available for students who are interested in international study, need to file petitions to waive college academic regulations, have disability concerns, are experiencing academic difficulties, or have requests for tutoring. The staff coordinates new student orientation, award ceremonies, commencement activities, and the activities of Ho-Nun-De-Kah, the college's honor society. Students seek counseling and advising on a variety of issues including academic problems, course problems and college procedures, graduation requirements, personal and family problems, stress management, and time management. Two counselors provide short-term counseling with an expertise in college policies and guidelines. Counseling is framed as appropriate to each student's academic circumstances. The staff is available on a walk-in basis, as well as by appointment in 140 Roberts Hall. Visit www.cals.cornell.edu/advising. Counseling and Advising staff: Lisa Ryan, Bonnie Shelley, Pamela Torelli, Tamara Durham.

The Office of Multicultural and Diversity Programs serves to monitor, support, and influence policy on behalf of all underrepresented students within the College of Agriculture and Life Sciences. This population is defined as encompassing, but not limited to, all African American, Latin American, Asian American, and Native American students. Its constituency includes students, faculty, and the general public. In the past academic year this represented approximately 20 percent of the college's undergraduate population. Additionally, the office is charged with monitoring and programming for the Educational Opportunity Program (EOP) and Prehealth Collegiate Science and Technology Entry Program (CSTEP). EOP and CSTEP are state-supported programs intended to assist New York State students who meet economic and

academic criteria set by the college, State Programs Office, and New York State Board of Regents. For further information, please contact Catherine Thompson in 140 Roberts Hall.

Within the university, the Office of Multicultural and Diversity Programs is charged with acting as the college liaison with the central Office of Minority Education Affairs, Learning Strategies Center, and the State Programs Office. Other university connections include the University Career Center and the Office of Financial Aid regarding concerns of the underrepresented student population. The director provides support for the CALS Diversity Committee. The director together with peer advisors carries out the duties of the office. The staff acts as a major advocacy group, as well as an information and referral center.

Given the college's policy on nonexclusionary programming, the Office of Multicultural and Diversity Programs is also responsible for some functions that serve the college's entire population. At present, that includes general college diversity activities, serving as the college prehealth advisor, and providing ongoing support at all levels for the Office of Counseling and Advising.

The CALS Registrar's Office ensures the accuracy, confidentiality, and reliability of student records and serves as an important link between the university's and college's policies and procedures and the student. The Registrar's Office maintains student records and reviews degree progress on a semester basis, maintains the Dean's List, evaluates and applies non-Cornell credit (transfer credit, study abroad credit, and advanced placement credit), provides registration and enrollment information, consults individually with students on graduation requirements, and schedules all CALS courses. Specific information can be found at www.cals.cornell.edu/current/registrar/.

The CALS Registrar's Office holds walk-in hours to assist students with any registrar-related issue. Walk-in hours are Tuesdays from 9:00 to 11:00 A.M. and Wednesdays from 2:00 to 4:00 P.M. in 140 Roberts Hall. No appointment is necessary during these times. Registrar's Office staff: Melanie Holland, Torrey Jacobs, Elisa Rafferty.

The Office of Career Development offers a variety of helpful services to all students and alumni of the college. Career development includes self-assessment, career exploration, decision making, and transition to employment or further study. Services are designed to assist students and alumni with those activities and to help them develop the career planning and job search skills they will find useful as their career paths progress and change.

The Career Library contains an extensive collection of current and useful material, including career information books, extensive internship files, employer directories, and job listings. Alumni Career Link is a database of more than 400 college alumni who have offered to help students and alumni with their career development in a variety of ways. Job search talks on topics such as résumé writing, cover letter writing, and interview skills are presented throughout the semester and are available on videotape. An active on-campus recruiting program brings more than 50 employers to campus each year to interview students for full-time and summer jobs. Additionally, the office provides information on hundreds of internships.

The office, in conjunction with a network of college faculty and staff members, assists students throughout their undergraduate years and beyond. For further information, students should contact Amy Benedict-Augustine, Laurie Gillespie, Sheri Mahaney, Sharon Radcliffe, or Jo-Lynn Buchanan in 177 Roberts Hall.

The CALS Admissions Office is responsible for admitting and enrolling a talented and diverse class of students each year. The process and outcome must reflect and support the college mission and help to meet college and institutional enrollment goals. This includes freshman, transfer, and intra-university transfer student processes. The office hosts on- and off-campus information sessions for prospective students, evaluates and makes decisions on more than 4,000 applications each year, and coordinates Cornell Days for admitted students each April. The Admissions Office staff advises and supports the CALS Ambassador program. The office is located in 177 Roberts Hall. Staff members include Ann LaFave, Cathy Sheils, Tara Bubble, Jared Rivers, Lorie Fessenden, and Heather Orkin.

Financial aid is administered through the university office in Day Hall. Endowment funds and annual donations in the college provide supplemental aid for students who are eligible for financial aid. Information about these college grants is available from the Office of Academic Programs in 140 Roberts Hall for students who have their financial aid package established through the university office in Day Hall. Grants are processed through the university's Office of Financial Aid.

Students

Undergraduate enrollment is approximately 3,100, with about 56 percent in the upper division. Each year about 850 students are graduated, while 635 freshmen and 250 new transfer students are enrolled. College faculty members serve as chairs of the Special Committees of roughly 1,000 graduate students.

Admission

The CALS Admissions Office selects applicants who are academically well prepared and will benefit from the college's various curricula.

While approximately half of CALS students come from New York State, about 42 percent come from other parts of the United States or abroad. Slightly more than half of the undergraduates are women. Approximately 24 percent are self-identified as members of minority ethnic groups.

The CALS Admissions Office is in 177 Roberts Hall (255-2036; www.cals.cornell.edu/admissions/).

Transfer Students

All accepted transfer credit must be from an accredited college or university. Transfer credit is awarded based on review of official transcripts. Additional course information may be required. Contact the CALS Registrar's Office for information. A maximum of 60 non-Cornell credits may be transferred.

Approximately 30 percent of CALS undergraduate students are transfers who have completed part of their collegiate work at community colleges, agricultural and technical colleges, or four-year institutions. Many of them hold an associate's degree. Detailed information on transfer admission is available from the CALS Admissions Office.

Intra-University Transfer

A Cornell student in good standing may apply for an intra-university transfer to pursue an academic program unavailable in their current college. Guidelines are available in the CALS Admissions Office. The procedure involves attending an information session, meeting with a faculty member in the proposed area of study, and submitting an application and letter of interest.

Consideration is given to students who have demonstrated an interest in their proposed new field of study by taking appropriate prerequisite courses. Academic achievement is also considered. Freshmen are not admitted—students need to spend two semesters in their home college before applying. In certain cases, a student may be referred to the Internal Transfer Division (ITD) to study for one semester before entering the college. A second semester in ITD is considered only in unusual circumstances. During this trial semester, the student must achieve a predetermined average (usually 2.7) and take approved courses to assure acceptance.

Special Students

A limited number of nondegree candidates who want to take courses in the college are admitted each year. Applicants should submit the standard Cornell transfer application, a résumé of their work experience, and a list of the courses in which they are interested. For more information and guidelines, students should contact the CALS Admissions Office.

Off-Campus Students

Programs in which students study off campus but enroll for Cornell credit include SEA semester, Semester in Environmental Science with the Marine Biology Laboratory, field study in Human Ecology or Industrial and Labor Relations, Albany programs, Cornell in Washington, student teaching, IPM internship, and clinical microbiology internship.

Facilities

The College of Agriculture and Life Sciences is located on the upper campus, up the hill from the central area of Cornell University, on land that was once part of the Ezra Cornell family farm.

Buildings around the area commonly known as the Ag Quad house classrooms, offices, and laboratories. Flanking them are the greenhouses, gardens, and research facilities. Nearby orchards, barns, field plots, forests, and streams extend as far as the Animal Science Teaching Research Center at Harford and the New York State Agricultural Experiment Station at Geneva.

Roberts Hall serves as headquarters for the administrative units, including offices of the deans and directors of academic programs, Cornell University Agricultural Experiment

Station, and cooperative extension. Included in the Office of Academic Programs are the director and associate director, the Admissions Office, the Career Development Office, the Counseling and Advising Office, the Office of Multicultural and Diversity Programs, and the Registrar's Office.

Mann Library, with its extensive collections of materials in the agricultural and life sciences, is at the east end of the Ag Quad. The student lounge and service center, known as the Alfalfa Room, and many of the college classrooms are in Warren Hall. Public computer facilities are available in Warren Hall, Riley-Robb Hall, and Mann Library.

DEGREE PROGRAMS

The College of Agriculture and Life Sciences offers programs leading to the degrees bachelor of science, master of science, and doctor of philosophy. Professional degrees include the master of professional studies and the master of arts in teaching. Some registered professional licensing and certification programs are also available.

Each curriculum in the college creditable toward a degree is registered with the New York State Education Department.

Bachelor of Science Degree

Departments in the College of Agriculture and Life Sciences sponsor study for the B.S. degree in 24 major programs. To qualify for the degree, students must fulfill requirements established by the faculty of the college and administered through the Office of Academic Programs. Students are admitted into a single major but afterwards may pursue and graduate with two or more majors within the College of Agriculture and Life Sciences. Students need an advisor in each major. Course requirements for double majors may overlap. The Counseling and Advising Office (140 Roberts Hall) and department representatives have a form for students to complete to officially recognize the double major. The following units offer major fields of study for undergraduates. A faculty advising coordinator is listed for each unit. Students should consult with the faculty coordinator regarding requirements and opportunities for concentrations in the major.

Majors

Agricultural science: Antonio DiTommaso, 903 Bradfield Hall, ad97@cornell.edu

Agriculture science education: William Camp, 416 Kennedy Hall, wgc4@cornell.edu

Animal science: W. Bruce Currie, 434 Morrison Hall, wbc1@cornell.edu

Applied economics and management: Dale Grossman, 205 Warren Hall, dag14@cornell.edu

Atmospheric science: Mark Wysocki, 1114 Bradfield Hall, mww3@cornell.edu

Biological engineering: James Bartsch, 314 Riley-Robb Hall, jab35@cornell.edu

Biological sciences: Jeffrey Doyle, 200 Stimson Hall, jjd5@cornell.edu; Bonnie Comella, 216 Stimson Hall, bec3@cornell.edu

Biology and society: Brian Chabot, 102 Little Rice, bfc1@cornell.edu

Biometry and statistics: Steven Schwager, 424 Warren Hall, sjs5@cornell.edu

Communication: Brian Earle, 328 Kennedy Hall, boe1@cornell.edu

Crop and soil sciences: Gary Fick, 507 Bradfield Hall, gwf2@cornell.edu

Development sociology: Tom Hirschl, 333 Warren Hall, tah4@cornell.edu

Entomology: John Losey, 4126 Comstock Hall, jel27@cornell.edu

Environmental engineering: James Bartsch, 314 Riley–Robb Hall, jab35@cornell.edu

Food science: Janice Brown, 107 Stocking Hall, jmb14@cornell.edu

Information science: Christine Stenglein, 303 Upson Hall, cms242@cornell.edu

Interdisciplinary studies: Lisa Ryan, 140 Roberts Hall, lar4@cornell.edu

International agriculture and rural development: Terry Tucker, 33 Warren Hall, twt2@cornell.edu

Landscape architecture: Peter Trowbridge, 440 Kennedy Hall, pjt4@cornell.edu

Natural resources: Tim Fahey, 12 Fernow Hall, tjf5@cornell.edu

Nutritional sciences: J. Thomas Brenna, B38 Savage Hall, jtb4@cornell.edu

Plant sciences (plant biology; plant genetics and breeding; horticulture, plant pathology/protection): Peter Davies, 255 Plant Sciences Bldg., pjd2@cornell.edu

Science of earth systems: Bryan Isacks, 3110 Snee Hall, bli1@cornell.edu

Science of natural and environmental systems: Tim Fahey, 12 Fernow Hall, tjf5@cornell.edu

Minors

Students in the College of Agriculture and Life Sciences may pursue one or more minor fields of study. Minor fields of study do not require an academic advisor, but each minor field has a contact person who will provide information and verify on the application to graduate that the student will successfully complete the requirements of the minor by graduation. Students may complete as many minors as they wish; the requirements of minors may overlap. Minors are described along with the majors later in the CALS section of this catalog. Not all majors or departments offer minors. Minors available in CALS can be found on the CALS counseling and advising web site (cals.cornell.edu/cals/current/advising/options/doubmaj.cfm). For minors outside of CALS, please consult with the specific department.

Early Enrollment in Cornell Graduate Programs

The College of Veterinary Medicine may accept students who are then permitted to double-register in their seventh and/or eighth semester and complete requirements for the bachelor of science degree in the College of Agriculture and Life Sciences. Students should consult with the college registrar, 140 Roberts Hall, to file an application for dual-enrollment and to ensure that degree requirements have been fulfilled.

Students who have been offered admission to the S. C. Johnson Graduate School of Management may take management courses in their senior year if approved by their college faculty advisor as part of their undergraduate program. These courses count toward the endowed college credits (maximum 55 without additional tuition charge). Students may consult with the college registrar, 140 Roberts Hall, to verify degree requirements and endowed credits earned.

The Department of Landscape Architecture offers a first professional degree curriculum in landscape architecture at both undergraduate (BSLA) and graduate levels (MLA I), as well as a second professional graduate degree program (MLA II). The curricula for both the undergraduate and graduate programs are accredited by the Landscape Architecture Accreditation Board (LAAB). The graduate program is cosponsored by the Department of Landscape Architecture in the College of Agriculture and Life Sciences and by the College of Architecture, Art, and Planning.

Graduate Fields of Study

Graduate study is organized by fields that generally coincide with the academic departments but may draw faculty from several disciplines in the various colleges of the university. The following graduate fields have primary affiliation in Agriculture and Life Sciences. Current directors of graduate studies are also listed. For more information on graduate programs, please refer to the Graduate Bulletin, or www.gradschool.cornell.edu/. Information following this list refers to undergraduate studies.

Agriculture and life sciences [M.P.S. (agr.)]: Don Viands, 151 Roberts Hall, drv3@cornell.edu

Agricultural economics: Loren Tauer, 451 Warren Hall, lwt1@cornell.edu

Animal breeding: John Pollak, B-47 Morrison Hall, ejp6@cornell.edu

Animal science: Richard Quaas, B-47 Morrison Hall, rlq1@cornell.edu

Atmospheric sciences: Kerry Cook, 3114 Snee Hall, khc6@cornell.edu

Biochemistry, molecular, and cell biology: Volker Vogt, 358 Biotechnology Bldg., vmv1@cornell.edu

Biological and environmental engineering: Dan Aneshansley, 306 Riley-Robb Hall, dja4@cornell.edu

Biometry: Marty Wells, 301 Malott Hall, mtw1@cornell.edu

Communication: Bruce Lewenstein, 321 Kennedy Hall, bvl1@cornell.edu

Development sociology: Lindy Williams, 336 Warren Hall, lbw2@cornell.edu

Ecology and evolutionary biology: Harry Greene, E251 Corson Hall, hwg5@cornell.edu; Irby J. Lovette, 188 Johnson Center, Lab of Ornithology, ijl2@cornell.edu

Education [also M.A.T.]: John Sipple, 421 Kennedy Hall, jws28@cornell.edu

Entomology: Cole Gilbert, 6136 Comstock Hall, cg23@cornell.edu

Environmental toxicology: Andrew Yen, Stocking Hall, ay13@cornell.edu

Food science and technology: Martin Wiedmann, 412 Stocking Hall, mw16@cornell.edu

Genetics and development: staff, 107 Biotechnology Bldg., dmc18@cornell.edu

Horticulture: Nina Bassuk, 33 Plant Science Bldg., nlb2@cornell.edu

International agriculture and rural development [M.P.S. (agr.)]: Steven Kyle, 249 Warren Hall, sck5@cornell.edu

International development: Norman Uphoff, 33 Warren Hall, ntu1@cornell.edu

Landscape architecture [M.L.A.]: Dan Krall, 440 Kennedy Hall, dwk5@cornell.edu

M.P.S. agriculture with Peace Corps option (offered by most agriculture fields with M.P.S. programs): Jim Haldeman, 36 Warren Hall, or see director of graduate studies for chosen field, jeh5@cornell.edu

Microbiology: James Shapleigh, 257A Wing Hall, jps2@cornell.edu

Natural resources: Clifford Kraft, 16 Fernow Hall, cek7@cornell.edu

Neurobiology and behavior: David Deitcher, W125 Mudd Hall, dld14@cornell.edu

Nutritional sciences: Christine Olson, 376 MVR Hall, cmo3@cornell.edu

Physiology: Mark Roberson, T6-008a Vet Research Tower, msr14@cornell.edu

Plant biology: Thomas Owens, 217 Plant Science Bldg., tgo2@cornell.edu; Robert Turgeon, 256 Plant Science Bldg., ert2@cornell.edu

Plant breeding: Lisa Earle, 514 Bradfield Hall, ede3@cornell.edu

Plant pathology: Michael Milgroom, 357 Plant Science Bldg., mgm5@cornell.edu

Plant protection [M.P.S. (agr.)]: William Reissig, Barton Laboratory, Geneva Campus, whr1@cornell.edu

Soil and crop sciences: Janice Thies, 719 Bradfield Hall, jet25@cornell.edu

Statistics: Robert Strawderman, 1172 Comstock Hall, rls54@cornell.edu

Zoology: John Hermanson, T5002A Vet Research Tower, jwh6@cornell.edu

OPPORTUNITIES IN RESEARCH

Undergraduate Research

A multitude of opportunities to be engaged in research exists across the College of Agriculture and Life Sciences and the university.

Students may be able to work on a faculty member's research project for pay. Opportunities can be explored by contacting individual faculty members; departmental offices; the CALS Career Development Office, in 177 Roberts Hall; or Cornell Career Services, in 103 Barnes Hall. Another option is to receive credit through a 499-level course within a department by conducting your own research project under a faculty mentor. More than 600 students each year conduct research for credit. Upperclass students usually have the course background to engage in research, but freshmen and sophomores also may be equipped to do some types of research. Off-campus research experiences are also available for pay or as internships.

The following web sites provide information about research and internships:

CALS Career Development Office: www.cals.cornell.edu/cals/current/career/

CALS Undergraduate Research Opportunities: www.cals.cornell.edu/cals/current/student-research/undergrad/ (information on how to explore research opportunities)

CALS Research Honors Program: www.cals.cornell.edu/cals/current/student-research/honors/

CALS Undergraduate and Graduate Student Grants Proposal Development: www.cals.cornell.edu/cals/current/student-research/grants/

CALS Undergraduate Minority Research: www.cals.cornell.edu/cals/current/student-research/minority/

CALS Internship Guidelines: www.cals.cornell.edu/cals/current/student-research/internship/

Undergraduate Research @ Cornell: www.research.cornell.edu/undergrad/

Cornell Undergraduate Research Board: www.research.cornell.edu/curb/ (student organization to promote and facilitate undergraduate research)

Biological Sciences: www.biology.cornell.edu/

Research Honors Program

The Research Honors Program provides students with a special opportunity to work with a faculty mentor to experience the research process. Successful completion requires a thesis written in the style of a master's thesis or scholarly journal article. Original honors research may be suitable for publication in a professional journal. Students are required to send an electronic version of their thesis title, abstract, and the research advisor's name to Ann Gantner, amg28@cornell.edu, by the end of the spring semester. In addition to copies of the entire thesis requested by the program area, one copy is required by the Office of Academic Programs (140 Roberts Hall). This copy will be made available in Mann Library. Students may volunteer to publish their theses in the Internet-First University Press if it does not interfere with other plans, such as patenting or publishing in another journal. During each summer the *CALS Research Honors Abstracts* is published as a compilation of honors theses abstracts.

The bachelor of science degree with "distinction in research" is conferred upon those students who, in addition to having completed the requirements for the B.S. degree, have satisfactorily completed the honors program and have been recommended for the degree by the honors committee.

Research may be done in these program areas: animal sciences, biological sciences, biology & society, entomology, information science, landscape studies, natural resources, nutritional sciences, physical sciences, plant sciences, and social sciences. Each program area has its own requirements in addition to the college requirements. After reviewing the requirements of each program area (below), students' questions may be directed toward the appropriate program area chair.

Consult "Undergraduate Research Opportunities" on the web (cals.cornell.edu/cals/current/student-research/undergrad/) for information about identifying a research topic, conferring with a faculty member, and undergraduate funding opportunities.

Honors Program Requirements

An undergraduate wishing to enroll in the honors program must have completed at least 55 credits, at least 30 of those 55 at Cornell. In addition, the student must have attained a cumulative Cornell GPA of at least 3.0 (unless otherwise noted by a particular program) at the time of entry.

Interested students must submit a written application and thesis proposal early in the first semester of their senior year; however, they are encouraged to make arrangements with a faculty member during the second semester of their junior year. Several program areas require students to submit their applications and thesis proposal to the program area honors committee chair by the end of the third week, while other program areas have students submit the application and proposal to the CALS Registrar's office by the end of the sixth week. *It is the student's responsibility to know the deadlines and submission procedures for the particular program area of interest.* Application forms are available from the CALS Registrar in 140 Roberts Hall or from the web at www.cals.cornell.edu/cals/current/student-research/honors/. Applications for biological sciences students can be picked up at 200 Stimson Hall, and for biology & society students at 306 Rockefeller Hall.

Before the completed application is submitted, signatures of approval are required in the following order: faculty research mentor, academic advisor, and research honors program area chair. After the college registrar verifies the student's GPA, the student will be officially enrolled in the honors program. *Additional requirements for application and completion of the program are described under each program area.*

Academic credit also may be earned by enrolling in an appropriate independent research course (required by some program areas). When applying for admission to the program, the student may, if appropriate, submit a budget and a modest request for research funds (up to $350). If approved, the funding will be transferred to a departmental account of the student's research advisor to support the student's research. This funding is not to be used as a student salary. Additional funding opportunities are described at cals.cornell.edu/cals/current/student-research/undergrad.

Unless otherwise indicated in the following program area descriptions, the research report in the form of a thesis or journal article should be submitted to the research program committee no later than four weeks before the end of classes of the semester in which the student expects to graduate. Students in the College of Agriculture and Life Sciences wishing to participate in the Research Honors Program are not eligible for

distinction in research by participating in a program offered by another college or administrative unit.

The research honors committee for each program area recommends to the college registrar those students who qualify for honors. Only those who maintain a GPA of at least 3.0 will be graduated with "distinction in research."

At or near the completion of their research, students are required to give an oral presentation or poster session during an appropriate event. Some departments have seminar series when presentations may be given. The Cornell Undergraduate Research Board (CURB) Forum is another venue for presentations.

For more information, go to www.cals.cornell.edu/cals/current/student-research/honors/.

The following are the honors program areas:

Animal Sciences

Faculty committee: S. M. Quirk, chair; Y. R. Boisclair, J. R. Giles, J. Gavalchin, P. A. Johnson, T. R. Overton

The objective of the animal sciences research honors program is to provide outstanding undergraduates with the opportunity to pursue supervised independent research and to develop an awareness of the scientific process. It is expected that the research will require significant effort and creative input by the student in its design and execution and in the reporting of the results.

Those students with majors in animal sciences who are interested in doing a research project should consult with their faculty advisors by their junior year. All students are expected to meet the college requirements in qualifying for the program and to complete the following:

- Identify a potential research honors project sponsor (i.e., a faculty member working in the animal sciences) and secure that faculty member's commitment to sponsor the student in the research project. This should be accomplished by the second semester of the junior year. Students are encouraged to implement some research during the junior year and/or summer before the senior year.
- Register for AN SC 499 Undergraduate Research.
- Participate in AN SC 402 Seminar in Animal Sciences, during the spring semester and report on and discuss the project and results.
- Submit a written thesis to the Animal Sciences Research Honors Committee by the scheduled deadline. Specific information regarding deadlines, format, and organization for the thesis will be provided.
- Meet with the Animal Sciences Research Honors Committee for a short oral defense of the thesis following a review of the thesis by the student's sponsor and the research committee.

Details pertaining to the specific requirements of the program can be obtained from the administrative office of the Department of Animal Science, 149 Morrison Hall.

Biological Sciences

Students interested in the Research Honors Program in the biological sciences should consult with their faculty advisors and with potential faculty research sponsors early in their junior year. See "Independent Research and Honors Program" in the Biological Sciences section of this catalog for complete details. Information on faculty research, applications, and program requirements may be obtained from the Office of Undergraduate Biology, 216 Stimson Hall.

Biology & Society

Faculty committee: D. Pimentel, chair

The Research Honors Program in Biology & Society is designed to provide independent research opportunities for academically talented undergraduate students in biology & society. Students who enroll in this program are expected, with faculty guidance, to do independent study and research dealing with issues in Biology & Society. Students participating in the program should find the experience intellectually stimulating and rewarding whether or not they intend to pursue a research career.

Biology & Society students are considered for entry into the research honors program at the end of the second semester of the junior year. Application forms for the program are available in the Biology & Society office, 306 Rockefeller Hall. To qualify for the Biology & Society Research Honors Program, a student must have an overall Cornell cumulative GPA of at least 3.3, have formulated a research topic, and have found a project supervisor (with a Cornell academic appointment) and a Biology & Society faculty member willing to serve as his or her advisor. The director of undergraduate studies will appoint a third reader of the completed research thesis. Applications will be reviewed by a committee headed by the director of undergraduate studies, who will notify students directly of the outcome. Students will be permitted to register for the research honors program only by permission of the biology & society program. Students must enroll for two semesters for 8 credits each in B&SOC, ALS, or HE 499, Honors Project I and II. More information on the honors program is available in the Biology & Society office, 306 Rockefeller Hall (255-6047).

Important Deadlines

Note: If the following dates fall on a weekend, the deadline is the preceding Friday.

- Last week of second semester of the junior year: Application for honors program submitted to 306 Rockefeller Hall.
- April 11: Thesis completed in a form satisfactory for evaluation and submitted to the three readers.
- April 25: Thesis defense accomplished.
- May 9: Two bound copies of completed and defended thesis submitted to director of undergraduate studies.

Entomology

Faculty committee: C. Gilbert, chair

The Program. A research honors program in entomology may be pursued by any qualified student in the College of Agriculture and Life Sciences. The student need not be specializing in entomology. Insects, because of their variety, small size, and easy availability, are convenient subjects for studying a wide array of problems dealing with living systems. Short life cycles, unique physiologies and developmental patterns, and species with easily managed colony requirements and a wide range of behavioral traits provide the raw material for research honors study. Cornell's diverse faculty interests and extensive collections and library in entomology are also major assets if a student selects entomology as the area for research honors study.

Research honors students have the option of earning academic credit by enrolling in ENTOM 497 Independent Study during any semester while working toward a research honors thesis. Credits and grade option for satisfying requirements of ENTOM 497 should be discussed with the thesis advisor (following page.)

Note: Enrolling in independent study is not a requirement for graduating with distinction in research honors in entomology.

Sequence of Requirements The Entomology Research Honors Committee requires that an undergraduate who is interested in embarking on a research honors project proceed with the following steps:

1. Discuss the matter with his or her academic advisor, preferably in the junior year. This schedule makes it possible to carefully plan a research project and implement some research during the junior year and/or summer before the senior year.
2. Select an appropriate faculty member in the Department of Entomology who can serve as a supervisor to oversee the honors research. This need not be the student's academic advisor. The academic advisor will be of assistance in determining which faculty entomologist has expertise most compatible with the interests of the student.
3. Prepare a brief, tentative plan for the project for discussion and approval of the honors project supervisor. The plan should include a statement of objectives or hypotheses, proposed methods for testing hypotheses, needs for laboratory space or shared equipment, and a budget outlining financial support needed for travel and supplies.
4. Submit a completed application and proposal approved by the honors project supervisor to the chair of the Entomology Research Honors Committee no later than the end of the fifth week of the first semester of the senior year. Earlier submission is encouraged. Applications are available from the CALS registrar, 140 Roberts Hall. These applications include an opportunity to request a modest amount of funding from the CALS honors program. These funds are distributed only one time per year (in late fall).

5. Submit a brief progress report, approved by the project supervisor, to the Entomology Research Honors Committee by midterm of the semester in which the student will complete his or her graduation requirements.
6. Present a formal seminar reporting the significant findings of the research to the Department of Entomology (as a Jugatae seminar) in the last semester of the senior year.
7. Submit two copies of the final honors thesis (as approved by the thesis supervisor) to the chair of the Entomology Research Honors Committee no later than two weeks before the last day of classes in the semester in which the student anticipates graduation. The thesis will be reviewed by the faculty honors project supervisor and one other referee selected by the chair of the honors committee.
8. Referees will return the thesis to the student one week before the last day of classes. If reviewers indicate that changes must be made, the revised thesis should be submitted to the Entomology Research Honors Committee chair no later than the last day of classes. Referees should include a recommendation to the Entomology Research Honors Committee chair regarding acceptability of the honors thesis. The approved honors theses will be bound and housed in the Entomology Library in Comstock Hall.

The complete text of this section can be found at: www.entomology.cornell.edu/Undergrad/EntomHonors.shtml.

Information Science

Students should follow the CALS social sciences guidelines to obtain research honors in information science.

Landscape Studies

Faculty committee: P. J. Trowbridge, chair

The research honors program in landscape studies offers outstanding undergraduates in CALS the opportunity to work with a member of the landscape architecture faculty to pursue supervised independent research in design, the cultural landscape, landscape archaeology, environmental design, and community-based planning and design. The student need not be a major in the landscape architecture professional design curriculum. The subject matter and nature of the research experience may be quite varied. Students participating should find the experience intellectually stimulating and rewarding, whether or not they intend to pursue a research career. The guidance and supervision of a faculty member with substantial interest and expertise in the subject is essential to the success of the project. It is expected that the research will require significant effort and creative input by the student in its design and execution and in reporting the results.

Students who consider this option should be aware that honors research is undertaken above and beyond any of the requirements for graduation in the major of landscape architecture. It involves a number of deadlines and a considerable time commitment. Before signing on for research honors, students need to consult with their academic advisor to make sure that honors research projects will not interfere with other academic or professional objectives, such as job applications, preparation of portfolios, or application to graduate school. These may need to be deferred until the thesis is complete. Students are responsible for meeting deadlines and being prepared for presentations and other meetings.

Although honors research credits for spring semester junior year and both semesters senior year are designated a letter grade, individual mentors may choose the R grade for work in progress until the project has been fully completed. Grade is determined by each student's mentor. The designation of "distinction in research" on the diploma is awarded at the recommendation of the faculty advisor and other referees to the honors committee chair. An outline of activities for both years is given below.

The Landscape Studies Research Honors Committee requires that an undergraduate who is interested in embarking on a research honors project proceed with the following steps:

1. Junior year: Identify a potential research honors project sponsor and secure that faculty member's commitment to sponsor the student in the research project. This should be accomplished early in the second semester of the junior year and be finalized by the end of the spring semester. Pre-register during the spring for the research honors program (LA 499).
2. Work with a faculty advisor to identify and formulate a research problem. If the faculty advisor is not in the Department of Landscape Architecture, select a co-advisor from the department to ensure that the research is consistent with the field.
3. Submit a completed application and proposal (approved by the honors project supervisor and the chair of the research honors committee) no later than the end of the fourth week of the first semester of the senior year. Earlier submissions are encouraged. These will be reviewed by ad hoc committee members, and successful thesis proposals will be submitted to the college honors committee by the sixth week.
4. Carry out an independent research effort that is original and separate from the work of others who may be investigating similar subjects.
5. Submit an outline of the thesis to the chair of the committee by the end of January for a May graduation.
6. Submit a draft to the readers by April 15. Describe and summarize the work within the range of formats used in the master's thesis program or professional journals in design or research. This version will be reviewed by the faculty supervisor and two *ad hoc* reviewers, and the student will be able to incorporate the committee's comments and suggestions into the final version, which will be due the last day of classes. Referees prepare a recommendation to the honors committee chair regarding the acceptability of the honors thesis.
7. Give two oral presentations to the group of other honors research students and invited faculty members. Both presentations are during the student's senior year.
8. Send two bound copies of the completed and defended thesis to the honors committee chair by May 13. These copies are in addition to the unbound copy required for Mann Library. A 250-word abstract must be provided electronically to the CALS Office of Academic Programs and must appear at the front of the thesis (see "CALS Requirements for Honors Thesis").

Natural Resources

Faculty director: J. B. Yavitt, chair

The research honors program in natural resources involves original, independent research that generates novel findings in applied ecology and resource policy and management. Students learn how to design and carry out research under the direct supervision and guidance of a faculty member or senior research associate in the department. Most students in the program begin their research before the start of the senior year, often in the summer after their junior year. Students may enroll and receive credit in independent study (NTRES 497 Honors Research in Natural Resources) during their honors research. The research findings are presented in a written thesis that is reviewed by two experts in the field. Many theses have been published in leading journals in the disciplinary area of the research. Although the format is not prescribed, the thesis usually consists of a short introduction, relevant materials and methods, a concise presentation of the meaningful data, a discussion, and the student's interpretation of the conclusions. Students also give an oral presentation of their research findings in a special symposium hosted by the department in early May.

Students should adhere to the following schedule.

Junior Year

1. File an informal application with the faculty director. The application includes a project description and advisor information.

Senior Year

1. Register for NTRES 497 before the add deadline (fall and spring).
2. Sixth week of fall semester: Submit formal application to faculty director (16 Fernow Hall).
3. March 31: Thesis should be close to completion.
4. April 15: Submit two copies of the thesis to the faculty director for *ad hoc* reviews.
5. May 3: Pick up *ad hoc* reviewers' comments from the faculty director.
6. May 15: Submit two copies of the final thesis: one for the college, one for the program director.
7. Week of May 25: Students will be notified of the decision, and the faculty director will recommend that each approved student graduate with "Distinction in Research."

Nutritional Sciences

Faculty committee: J. T. Brenna, C. Bisogni

The research honors program in the Division of Nutritional Sciences is a structured experience that involves (1) taking a course in research (NS 398), (2) conducting a research project through which the student becomes intellectually engaged in the whole research process, (3) completing a written thesis that reports the research, and (4) giving an oral presentation of the project at the undergraduate honors symposium. Students must maintain a minimum grade point average to graduate with honors in research.

The research honors program is an excellent opportunity for students who are highly interested in research and wish to commit substantial time and intellectual energy to a project that will span at least four semesters of their undergraduate experience. Honors students experience the excitement of participating in a project to generate new knowledge on a topic that interests them and reporting the project findings. By working with faculty mentors and other researchers, they develop skills in research methods and data analysis. Students also learn that research projects are labor intensive and that writing research reports, such as the honors thesis, is a vital, but time-consuming, aspect of the research process. This intensive research experience is not suitable for all students, and those who wish a less intensive research experience may conduct research with a faculty member under NS 401.

Students interested in the program should take NS 398 as early in their program as possible. Students may review program requirements at the NS 398 web site or contact the program directors. Acceptance into the research honors program occurs when the student (1) is accepted into a faculty member's research program and (2) submits a research proposal abstract that is approved by the directors of the research honors program.

Students interested in the program typically spend the spring sophomore semester and fall junior semester exploring honors project opportunities with prospective faculty mentors. Students are responsible for contacting faculty members and applying to their research programs, although some guidance in this process will be provided in NS 398. By the fall of the junior year, the student is expected to have identified their faculty member and be working with him/her on a proposal abstract, which is due early in the spring junior semester.

Students receive academic credit for work on their honors project under NS 499. The 6 required credits may be taken over several semesters. How much time is spent on the project each semester will be the decision of the student and the faculty mentor. For each three to four hours of work per week, the faculty mentor usually will assign one hour of academic credit. This applies to the preparation of the research plan and necessary library research (usually completed during the junior year) as well as the carrying out of the research itself and preparation of the thesis.

The research honors project is the major component of the research honors program. It should be well defined and sufficiently circumscribed to give the student the opportunity to develop the research plan, execute the research, and write an acceptable thesis within the limited time available to students carrying full academic loads. Typically, the project is designed early in the junior year and conducted in the spring junior semester and fall senior semester. Students may arrange with their faculty mentor to work on the project during the summer. The spring senior semester is usually devoted to writing the thesis (at least 25 pages). The student works with the faculty mentor to prepare a draft of the thesis, which is submitted before spring break to a second faculty member for evaluation. When comments are received from the reader, the student must revise the thesis to meet the criteria for acceptance. The student presents the thesis at the Honors Student Symposium at the end of the semester.

Physical Sciences

Faculty committee: A. T. DeGaetano, chair; S. J. Mulvaney, C. D. Bustamante

The research honors program in physical sciences provides outstanding students with an opportunity to do independent research under the supervision of a faculty member in the Departments of Biological and Environmental Engineering, Food Science, Earth and Atmospheric Sciences, or Biological Statistics and Computational Biology.

In addition to meeting the requirements of the college, the student is expected to:

1. Identify a thesis advisor and thesis topic before the end of the junior year.
2. Work with the thesis advisor to prepare a budget, short research proposal (2–3 pages), and application form. These materials must be received by the Physical Sciences committee chair by the end of the third week of senior year.
3. Enroll in the program for a minimum of two semesters.
4. Enroll in the appropriate departmental undergraduate research course for a total of at least 6 credits.
5. Submit an outline of the thesis to the chair of the committee by the end of January (for a May graduation).
6. Submit a draft of the thesis to the thesis advisor with sufficient lead-time for a revision to be prepared.
7. Submit three copies of the thesis and names of recommended reviewers to the chair of the honors committee by four weeks before the end of classes in the semester in which graduation is expected.

There is no required format, but the thesis is usually written in the form of a research journal article or a master's thesis.

Further details of the program can be obtained from the chair of the Physical Sciences Research Honors Committee.

Plant Sciences

Faculty committee: R. L. Obendorf, chair; I. A. Merwin, E. B. Nelson, F. S. Rossi, A. DiTommaso, M. E. Smith-Einarson

Students perform independent scientific research under the guidance of faculty members in the fields of horticultural, agronomic, and soil sciences; plant biology; plant genetics and breeding; and plant pathology. For admission to the program, students must meet college requirements and submit to the Plant Sciences Research Honors Committee a project proposal (two to three pages) that includes a title; a brief background of the problem (justification and literature review); a clear statement of objective(s) and hypotheses to be tested; methodology and experimental plan, necessary space, equipment and supplies; and a project budget. The proposal must be accompanied by a letter from the faculty supervisor stating that he or she has approved the project plan and that its completion within the remainder of the student's undergraduate tenure is feasible.

A brief progress report will be made to the committee usually during the third week of the spring semester. Research presentations are recommended (e.g., Cornell Undergraduate Research Board Spring Forum, department seminars, professional meetings).

Successful completion of the research honors program requires acceptance by the honors committee of two copies of a research report. The report should be written in the format of a research publication in the appropriate scientific field. The acceptable report must have been reviewed and corrected according to the recommendations of the research supervisor before the report is submitted to the honors committee. The report must be received by the honors committee at least two weeks before the last day of classes of the semester in which the degree is sought and must be accompanied by a letter from the research supervisor evaluating the research and, if appropriate, recommending graduation with distinction in research.

The research honors committee will review the report within one week and may accept it or return it to the student with specific recommendations for revisions. A suitably revised version must be submitted to the committee before the second day of the examination period. When the committee accepts an honors report, the chair will recommend to the associate dean and director of academic programs and to the college registrar that the student be graduated with distinction in research. One copy of the accepted report will be returned to the student with review comments from the committee.

Additional guidelines may be found at www.css.cornell.edu/Programs/PlantSciHon/.

Social Sciences

Faculty committee: N. Chau, M. Shapiro

Research projects in the social sciences include applied economics and management, communication, development sociology, education, and information science. Students are accepted into the social sciences research honors program of the College of Agriculture and Life Sciences after meeting all the college criteria described above, after evaluation of the student's written application, and on approval of a detailed thesis proposal. The application and proposal are due to the program area chair *no later than the third week* of the first semester of the senior year. Each student is encouraged to begin working on this proposal with a prospective faculty thesis advisor during the junior year. The purpose of the proposal is twofold. First, it formalizes a plan of study and establishes a set of expectations between the student and the faculty advisor. Second, the honors commit-

tee reviews the proposal to determine whether it is consistent with honors thesis requirements and to make suggestions for improvement.

The proposal should be 5 to 10 typed, double-spaced pages and include the following:

1. **Research Topic:** State the problem to be studied or the topic of interest. Review the basic literature and the background of the problem or topic; include a more extensive bibliography to be consulted.
2. **Research Questions/Empirical Hypotheses:** Specify the proposed questions to be answered or hypotheses to be tested empirically via collection of data and a mode of analysis accepted in the social sciences.
3. **Research Methods:** Discuss the models to be constructed (if any), sampling procedures, data collection procedures (including measurement instruments and survey or experimental designs, if appropriate), and proposed methods of analysis.
4. **Expected Significance:** State what new knowledge or information is likely to be forthcoming and why it is important. State any practical applications expected as a result of the research.

Faculty advisors must be members of the graduate faculty. Exceptions may be granted for persons with special expertise pending petition to the Social Science Research Honors Committee. Students should register for honors credit directed by the faculty research honors project advisor.

Distinction in research is awarded upon approval of the research honors thesis by the Social Sciences Research Honors Committee. Both the results of the research and the methodology (or the logical argument by which the results were achieved) must be reported. Reviews of the literature, practical conclusions or applications, or broad characterizations of an area of inquiry may constitute part of the research report but are not themselves sufficient as research.

Honors theses should be written according to the form of any standard journal within the appropriate field. The Honors Committee recommends the submission of the thesis draft to the research advisor two months before graduation to permit sufficient time for revision. Two copies of the thesis must be submitted to the chair of the Honors Committee no later than the middle of the second-to-last month before graduation (i.e., April or November). A supporting letter from the faculty member supervising the work also must be submitted. The thesis will be independently reviewed and further revisions may be required before the thesis is accepted. Final approval of the thesis requires a majority vote of the Honors Committee.

OFF-CAMPUS OPPORTUNITIES

Study off campus is of two types: (1) credit may be earned at another institution and transferred to Cornell, or (2) credit may be earned in Cornell courses that require off-campus activity.

Students who plan to enroll in courses at another institution should refer to the non-Cornell credit policies on p. 37. Information about enrolling at another institution outside of the United States can be found under "Study Abroad."

Albany Programs

Study off campus in Albany, the New York State capital, provides a unique opportunity to combine career interests with academic and legislative concerns. Two formalized opportunities are available. The Assembly Intern Program is offered in the spring semester and provides placement with a staff member of the New York State Assembly. The Senate Assistants Program also occurs during the spring semester and has placements with New York State senators and selected staff. Each program has an academic component as well. Check the individual folders in the internship files in the CALS Career Development Office, 177 Roberts Hall.

Applications are collected and processed by the CALS Career Development Office, 177 Roberts Hall, in the semester before assignments. Those accepted should plan a program of study in consultation with their faculty advisor. At least 12 credits must be carried to meet the full-time residency requirement. To receive academic credit for the Assembly Intern Program, students enroll in ALS 392. To receive academic credit for the Senate Assistants Program, students enroll in ALS 400. Information and applications are available in the CALS Career Development Office, 177 Roberts Hall.

Cornell in Washington

The Cornell in Washington program offers students from all colleges in the university an opportunity to earn full academic credit for a semester in Washington, D.C. Students take courses from Cornell faculty members, conduct individual research projects, and work as externs. Students take part in a public policy or humanities seminar, serve as externs in federal agencies, congressional offices, or nongovernmental organizations, and carry out individual research projects under the supervision of Cornell faculty members. The required externships and all course enrollments are arranged through, and approved by, the Cornell in Washington program. Students in the College of Agriculture and Life Sciences must register for ALS 500 and cannot receive credit for the externship experience alone. For further information, see p. 21, inquire at M101 McGraw Hall, 255-4090, or visit ciw.cornell.edu.

Marine Biological Laboratory's (MBL) Semester in Environmental Science

The Marine Biological Laboratory's (MBL) Semester in Environmental Science is a semester-long program held each fall in Woods Hole, Massachusetts. This is a multi-university and college program run by the staff of the Ecosystems Center of the MBL. Approximately 15–20 students interact intensively with the world-class research staff of the Ecosystems Center in a mixture of classroom, laboratory, and field-research activities. The major foci of the program are on biogeochemistry, ecosystem science, and the impacts of land use and global change on the environment. Students spend about 20 hours each week conducting intensive, hands-on field and lab work in coastal forests, freshwater ponds, and estuaries, and complete an independent research project as part of the curriculum. The MBL is one of the oldest (founded in 1888) and most distinguished biological field stations in North America. Cornell credit for up to 16 credits is offered. More information on the program can be obtained from the Cornell faculty liaison (Prof. Bob Howarth, E309 Corson Hall, 255-6175) or from the director of the program (Dr. Ken Foreman, MBL Ecosystems Center, 508-289-7777; http://courses.mbl.edu/SES/).

SEA Semester

The Sea Education Association is a nonprofit educational institution offering ocean-focused academic programs and the opportunity to live, work, and study at sea. Science, the humanities, and practical seamanship are integrated in small, personal classes. The 17-credit program is 12 weeks in length. Six weeks are spent in Woods Hole, and the following six weeks are spent on either one of SEA's two sailing vessels: the *SSV Robert Seamans* or the *SSV Corwith Cramer*. For more information, contact the Cornell Marine Programs office, G14 Stimson Hall (255-3717) or visit www.sea.edu. CALS students should file an intent to study off campus form with the college registrar as early as possible to ensure proper registration and enrollment in courses.

Shoals Marine Laboratory (SML)

The Shoals Marine Laboratory, run cooperatively by Cornell University and the University of New Hampshire, is a seasonal field station located on 95-acre Appledore Island off the coast of Portsmouth, N.H., in the Gulf of Maine. SML offers undergraduates and other interested adults a unique opportunity to study marine science in a setting noted for its biota, geology, and history. Please refer to "Courses in Marine Science," in the section on the Office of Undergraduate Biology, for a list of courses offered.

For more information, contact the Shoals Marine Laboratory office, G14 Stimson Hall, 255-3717, or visit www.sml.cornell.edu.

Internships

Several departments in the college offer supervised internships for academic credit. Internships may be granted for pay and/or credit with a limit of up to 3 credits per internship and no more than 6 credits total allowed for internships consisting of off-campus work experiences that do not have the continued presence of a Cornell faculty member. The number of credits awarded should reflect the amount of knowledge gained per internship and/or following the CALS guidelines for assigning credits. The 6-credit allotment includes transfer credit and credit from other internships in other colleges at Cornell. The 6-credit limit does not apply to secondary, post-secondary, and Cooperative Extension teaching internships in the Department of Education. The awarding of credit will not be allowed in cases where a student brings to the college or to a professor a description of a past experience and requests credit. Note that a maximum of 15 (prorated for transfer students) of the 120 credits required for the degree may be taken in internships, independent study courses, and undergraduate teaching or research. For

internships not governed by an established internship course, the student must enroll in a 497-level course for the number of credits assigned.

To ensure a fair and manageable system to deal with internships, the College of Agriculture and Life Sciences has set forth guidelines to serve as minimum requirements for a student to receive internship credit.

1. Credit will be assigned or accepted only in cases in which a Cornell faculty member is directly involved in determining both the course content and in evaluating the student's work.
2. The internship should be purposeful, provide opportunities for reflection, present a continual challenge to the student, and incorporate active learning, with the student an active participant in all stages of the experience from planning to evaluation.
3. Before a student begins the internship, a learning contract needs to be written between the Cornell faculty internship advisor on campus, the supervisor at the location, and the student. This contract should state the conditions of the work assignments, supervisor, learning goals, number of credits, and methods of evaluation of the work. A contract form can be obtained from the college Registrar's Office, or departments may have their own.
4. Students should further develop the internship experience based on the college Experiential Learning Criteria, which can be found on the web at cals.cornell.edu/cals/teaching/elr/
5. Students need to keep their faculty internship advisor updated on the progress of the internship while away from campus.

Arrangements should be made with the offering department for assignment of a faculty mentor for planning the program of work, and for evaluating student performance. Individual departments may add more requirements to the internship based on specific needs such as time constraints, faculty workloads, and the relationship of the internship to the goals of the department. The specific terms of the contract should be recorded, using the independent study, research, teaching, and internship form, available in the Registrar's Office in 140 Roberts Hall.

Pay and Credit for Undergraduate Research, Teaching, and Internships

Research: students can receive pay or credit, or they can partition it so that they receive pay for part of the research and credit for the other as long as the work does not overlap.

Undergraduate Teaching Assistant: students can receive either pay or credit, but they cannot partition it.

Internships: students may receive both pay and credit for the same internship experience.

Study Abroad

Each year about 200 CALS undergraduates spend an academic year or semester studying abroad. Whether attending a large university in Australia, a smaller campus in Sweden, or a technical school in Singapore, CALS students have a variety of international study options available to them. They can choose from:

- a CALS exchange program in Austria, Australia, Brazil, Denmark, Hong Kong, Mexico, Netherlands, New Zealand, the Philippines, Singapore, Sweden, Switzerland, or the United Kingdom;
- a study abroad program through the Cornell Abroad office;
- an international study tour as part of a CALS course, or a summer program.

CALS exchange programs are unique agreements created with other prestigious universities around the world. CALS students participating in an exchange program pay only their Cornell tuition, with no additional administrative fees. To learn more about the exchange programs, please visit: www.cals.cornell.edu/cals/current/abroad-exchange/.

Study abroad opportunities offered through the Cornell Abroad office are vast, ranging from a traditional university in London to field study in Africa. For information about specific programs, costs and more, visit their office in 300 Caldwell Hall or go to www.cuabroad.cornell.edu/.

Whether participating in a CALS exchange or a program through Cornell Abroad, all CALS students interested in studying abroad must receive approval from their faculty advisor and meet with the college study abroad advisor to review the college policies and to receive college approval. College policies can be viewed at: www.cals.cornell.edu/cals/current/abroad-exchange/going-abroad/policies.cfm.

Study abroad advising hours are held in 140 Roberts Hall on Tuesdays and Thursdays, 10:00 A.M. to 1:00 P.M. and Wednesdays 1:00 to 3:00 P.M.

Ithaca College and Wells College Exchange Programs

The Cornell University–Ithaca College Exchange Program is a reciprocal arrangement between Cornell University and Ithaca College that allows matriculated full-time students with prior approval and within stated stipulations, to cross-register at the other institution. No additional tuition is charged except in the case of undergraduate students enrolled during any one semester for a total of more than 18 credits (Cornell and Ithaca College combined). Those students are subject to additional tuition charges on a per-credit basis. This arrangement is available during the fall and spring semesters only, and is contingent upon space availability. A maximum of 12 credits may be taken through this program.

Cornell University also has a reciprocal arrangement with Wells College in Aurora, N.Y. For further information, contact the Cornell School of Continuing Education office, B20 Day Hall, 255-4987, or on the web at www.sce.cornell.edu/exmu/.

GRADUATION REQUIREMENTS FOR THE BACHELOR OF SCIENCE

Graduation Requirements

1. Credit Requirements

A. Minimum total credits: 120 academic credits are required for graduation.

Important Exceptions:

- Review or supplemental courses (e.g., 00-level courses) increase the number of credits required for graduation by the number of credits in the course. These credits *do* count toward the minimum 12 credits required for full-time status.
- Repeated courses increase the number of credits required for graduation by the number of credits in the course. These credits *do* count toward the minimum 12 credits required for full-time status.
- Physical education courses do not count toward 120 credits for graduation. They do *not* count toward the minimum 12 credits required for full-time status.

B. Minimum credits at Cornell: 60 academic credits must be completed at Cornell.

C. Maximum non-Cornell credits: 60 non-Cornell credits (AP, CASE, transfer, Cornell Abroad, and exchange credits) can be applied toward degree requirements.

D. Minimum credits from College of Agriculture and Life Sciences: 55 CALS credits are required for graduation. CALS credits include all courses from departments within CALS, and courses offered in the Biological Sciences, Earth and Atmospheric Sciences, Information Science, and Nutritional Sciences Departments. Specifically, courses offered under the following subject prefixes count as CALS credits: AIS, ALS, AEM, AN SC, BEE, BIO G, BIOAP, BIOBM, BIOEE, BIOGD, BIOMI, BIONB, BIOPL, BIOSM, BTRY, COMM, CSS, D SOC, EAS, EDUC, ENTOM, FD SC, HORT, IARD, INFO, LA, NS, NTRES, PL BR, PL PA.

E. Maximum credits from endowed colleges: 55 endowed credits can be completed without incurring excess tuition charges. Endowed credits include all courses from departments in the College of Arts and Sciences, Architecture, Art, and Planning, Engineering, the Hotel School, the Johnson School of Graduate Management, and the Law School. Courses completed during the summer and winter sessions do not count against the 55 endowed credit limit.

F. Minimum letter-graded credits: 100 (prorated for transfer students).

G. Maximum credits earned through independent study, research, teaching assistantships, and/or internships: 15 credits of "unstructured" course work can be applied toward graduation requirements (prorated for transfer students) (i.e., a minimum of 100 "structured" credits are required for graduation).

2. Physical Education Requirement

A. Pass two PE courses with a satisfactory grade.

Exception: External transfer students are credited with one course of physical education for each semester previously enrolled full-time (12 or more credits) at another college before matriculation.

B. Pass a required swim test, administered during orientation. External transfer students who are exempt from PE are exempt from the swim test.

C. Students are expected to complete the physical education requirement in their first two semesters at Cornell.

3. Residency Requirements

A. Eight semesters of full-time study are expected. Transfer students are credited with one semester in residence for each 15 credits earned at another institution.

B. Internal transfer students must be enrolled in CALS for at least two semesters, not including residency in the Internal Transfer Division.

C. The final semester before graduation must be completed in a Cornell program as a full-time student in continued good academic standing.

D. Students in the ninth and final semester may apply for prorated tuition. The eligibility criteria are listed below. The student will be charged the full administrative fee and student service charge, plus one-fifteenth of the remaining full tuition per credit hour.

All of the following conditions must be met in order for a student to be considered for prorated tuition:

1. The prorated semester is the ninth and final semester of study.
2. The student is in good academic standing with the college and the major.
3. Maximum of 11 credit hours of course work are allowed under prorated tuition. Students cannot exceed the number of credits approved or full tuition will be charged, and no refund will be allowed if fewer credits than applied for are completed.
4. Approval of the student's faculty advisor, the college registrar, and the university registrar is required for all requests. Note that approval is conditional until grades are finalized at the end of the semester immediately preceding the prorated semester. Should those grades indicate that more than the requested number of prorated tuition credits are required for graduation, prorated tuition will be adjusted accordingly.
5. Students applying to be prorated in the fall semester are encouraged to submit the application by May 1. The final deadline is June 1. Students applying to be prorated in the spring semester are encouraged to submit the application by December 15. The final deadline is January 15.

   Please be advised that prorated tuition may impact the student's financial aid, student loans, scholarships, non-Cornell health insurance programs, athletic eligibility, or other considerations. It is the responsibility of the student to resolve and rectify these situations prior to submitting this petition.

4. Grade-Point Average (GPA) Requirements

Minimum cumulative GPA: 2.00 or above must be maintained. The cumulative GPA includes all grades earned at Cornell.

5. Schedule Requirements

A. Students are expected to enroll in at least one CALS course each semester until 55 CALS credits have been earned.

B. Freshmen may not enroll in more than 18 credits, not including physical education.

C. Freshmen are limited to one S-U course per semester.

D. PE does not count toward the 12 credit minimum required for full-time status.

6. Distribution Requirements

The purpose of the distribution requirement is to provide a broad educational background and to ensure a minimum level of competency in particular skills. Through study of the physical and life sciences, students develop their understanding and appreciation of the physical sciences, enhance their quantitative reasoning skills, and gain an appreciation of the variability of living organisms. The social sciences and humanities give students perspective on the structure and values of the society in which we live, and prepare them to make decisions on ethical issues that will affect their work and role in society. Written and oral expression is designed to help students become competent and confident in the use of oral and written communication to express themselves and their ideas.

Please note: Credits received for independent study, field, teaching, research, work experience, and internships cannot be used to fulfill the distribution requirement. Courses judged to be review or supplemental in the discipline, such as 00-level courses, will not be counted in the distribution areas.

Physical and Life Sciences. 18 credits in at least three disciplines of which 6 credits must be introductory biology and 3 credits in chemistry or physics.

Introductory Biology: BIO G 101–104, 105–106, 107–108, 109–110

CHEM

PHYS

Other Physical/Life Sciences

AN SC 100, 110, 112, 215, 221, 280, 300, 301

AEM 210

ASTRO

BEE 454, 458, 459

Biological Sciences (any course EXCEPT BIO G 200, 209, 299, 498, 499, & BIONB 431, BIOSM 204)

BTRY/Statistics

CHEM

CSS 190, 260, 311, 312, 314, 315, 317, 366, 415, 455, 483

EAS (EXCEPT 121, 150, 420)

EDUC 115

ENTOM 201, 210, 212, 215, 241, 260, 277, 315, 325, 331, 332, 344, 369, 370, 455, 463

FD SC 200

HORT 220, 243, 317, 400, 426, 440, 445, 449, 455, 460

IARD 414

ILRST 210, 212, 310

Mathematics—(See CALS requirements for graduation.)

NS 115, 122, 222, 262, 320 (300), 331, 332, 341, 347, 361, 431, 441, 452

NTRES 101, 210, 310, 313, 314, 322, 323, 326, 413, 420

PAM 210

PHYS

PL BR 201, 225, 300, 401, 402, 403, 404

PL PA 201, 301, 309, 319, 401

SNES 101 (ALS 115)

Social Sciences and Humanities. Students must complete four courses of 3 or more credits each from the following six categories of courses in the humanities and social sciences.

- At least one course must be completed from three different categories.
- No more than two courses in the same department will be counted toward the distribution requirement.

Categories:

- Cultural Analysis (CA)
- Historical Analysis (HA)
- Knowledge, Cognition, and Moral Reasoning (KCM)
- Literature and the Arts (LA)
- Social and Behavioral Analysis (SBA)
- Foreign Language (FL)

Detailed descriptions follow.

Social Sciences and Humanities: Category Descriptions

Cultural Analysis (CA)

These courses study human life in particular cultural contexts through interpretive analysis of individual behavior, discourse, and social practice. Topics include belief systems (science, medicine, religion), expressive arts and symbolic behavior (visual arts, performance, poetry, myth, narrative, ritual), identity (nationality, race, ethnicity, gender, sexuality), social groups and institutions (family, market, community), power and politics (states, colonialism, inequality).

Historical Analysis (HA)

These courses interpret continuities and changes—political, social, economic, diplomatic, religious, intellectual, artistic, scientific—through time. The focus may be on groups of people, dominant or subordinate, a specific country or region, an event, a process, or a time period.

Knowledge, Cognition, and Moral Reasoning (KCM)

These courses investigate the bases of human knowledge in its broadest sense, ranging from cognitive faculties shared by humans and animals such as perception, to abstract reasoning, to the ability to form and justify

moral judgments. Courses investigating the sources, structure, and limits of cognition may use the methodologies of science, cognitive psychology, linguistics, or philosophy. Courses focusing on moral reasoning explore ways of reflecting on ethical questions that concern the nature of justice, the good life, or human values in general.

Literature and the Arts (LA)

These courses explore literature and the arts in two different but related ways. Some courses focus on the critical study of artworks and on their history, aesthetics, and theory. These courses develop skills of reading, observing, and hearing and encourage reflection on such experiences; many investigate the interplay among individual achievement, artistic tradition, and historical context. Other courses are devoted to the production and performance of artworks (in creative writing, performing arts, and media such as film and video). These courses emphasize the interaction among technical mastery, cognitive knowledge, and creative imagination.

Social and Behavioral Analysis (SBA)

These courses examine human life in its social context through the use of social scientific methods, often including hypothesis testing, scientific sampling techniques, and statistical analysis. Topics studied range from the thoughts, feelings, beliefs, and attitudes of individuals to interpersonal relations between individuals (e.g., in friendship, love, conflict) to larger social organizations (e.g., the family, society, religious or educational or civic institutions, the economy, government) to the relationships and conflicts among groups or individuals (e.g., discrimination, inequality, prejudice, stigmas, conflict resolution).

Foreign Language (FL)

These courses are taught by the following departments: Africana Studies and Research Center (AS&RC—language only), Asian Studies (BENGL, BURM, CHIN, HINDI, INDO, JAPAN, KHMER, KOREA, SANSK, TAG, THAI, and VIET), Classics (CLASS—language only), German Studies (GERST—language only, DUTCH, and SWED), Linguistics (LING—languages only), Near Eastern Studies (NES—languages only), Romance Studies (CATAL, FREN, ITAL, PORT, QUECH, and SPAN), and Russian Studies (RUSSA, HUNGR, POLSH, SEBCR, and UKRAN).

Diversity (D)

Although not a requirement, the college recommends that students take at least one diversity course.

Written and Oral Expression. 9 credits total, of which at least 6 must be in written expression. Oral expression is not required by the college (it may be for some majors); all 9 credits may be in written expression. Courses in written and oral expression may be selected from the following:

Oral Expression

COMM 201, 203

ENTOM 335

Written Expression

First-Year Writing Seminars

Sophomore Seminars

AEM 200

COMM 131 (117), 260, 263, 350, 352

ENGL 280, 281, 288, 289, 382-385, 388, 389

FD SC 230

LA 215

NS 105, 230

7. Quantitative Literacy Requirement

Faculty legislation requires minimum competency in quantitative literacy to complete a degree in the College of Agriculture and Life Sciences. This requirement can be satisfied in one of three ways:

- Earning a score of 4 or 5 on the AP Calculus exam; or
- Transferring an approved calculus or statistics course with a grade of "C" or better; or
- Taking an approved math or statistics course at Cornell.

A complete listing of approved math and statistics courses is available online at www.cals.cornell.edu/current/registrar/. Pre-approval forms are available in CALS Registrar's Office.

Non-Cornell Credit Policies

1. Non-Cornell credit includes:

- advanced placement credit (see p. 8 for further details);
- credit earned at an accredited college or university;
- credit earned through the Ithaca College and Wells College Exchange Programs;
- credit earned through a Cornell Abroad or CALS exchange program.

2. Non-Cornell credit is accepted by CALS when:

- the credits are earned at an accredited institution;
- the credits do not duplicate course work already completed at Cornell;
- the credits are earned before matriculating into CALS or during the summer or winter session or through Cornell Abroad or an approved exchange program;
- the credits have not been applied toward high school graduation requirements (except for AP exam credit, see p. 8);
- the grade earned is "C-" or better; and
- an official transcript is sent directly to the CALS Registrar's Office from the college/university where the credits were completed.

Please note: Cornell University does not accept credit for courses sponsored by colleges but taught in high schools to high school students, even if the college provides a transcript for such work. Students who have taken such courses may, however, earn credit by taking an appropriate examination as described on pp. 8–11 of this catalog.

3. A student may apply a maximum of 60 non-Cornell credits toward his or her graduation requirements.

   - If more than 60 non-Cornell credits have been completed, the CALS Registrar's Office will work with the student to determine which credits best fulfill CALS graduation requirements.
   - Cornell Abroad (not CALS exchange) credits are limited to 15 credits per semester, 30 per academic year.

4. Non-Cornell credits are recorded on the graduation summary and can be applied toward CALS credits, distribution requirements, and major requirements.

   - Non-Cornell courses that are similar to courses offered in CALS are recorded as CALS credits on the graduation summary and count toward the minimum of 55 CALS credits required for graduation.
   - Non-Cornell courses that are equivalent to Cornell courses that fulfill distribution requirements are recorded under the appropriate distribution area on the graduation summary.
   - Non-Cornell courses that are equivalent to endowed courses can be applied toward distribution requirements or general electives; however, these credits do not count against the maximum of 55 endowed credit hours.
   - If a course has no comparable course at Cornell, the Registrar staff will determine how the credit should be applied.
   - Faculty advisors determine how non-Cornell credit will be applied toward major requirements; the CALS Registrar's Office determines how non-Cornell credit will be applied toward CALS graduation requirements.

5. Students who have already matriculated into CALS and are planning to take courses at another institution should complete a transfer credit pre-approval form before completing the course work. Pre-approval forms are available in the CALS Registrar's Office in 140 Roberts Hall.

6. During the regular academic year, students can be enrolled in courses at both Cornell and another institution only if the student is taking a course not offered at Cornell. (Schedule conflicts or unavailability of courses in a given semester do not constitute valid rationales for concurrent enrollment at another institution.)

Graduation Procedures

1. The progress of each student toward meeting the degree requirements is recorded each semester in the CALS Registrar's Office on a graduation summary form. Students can review their graduation summary online at https://dust.cals.cornell.edu.

2. Students who have been in residence for eight semesters and who have met the graduation requirements will be graduated. Students are expected to attend for the full eight semesters even if they have completed the graduation requirements in fewer semesters. A student who wishes to either graduate early or delay graduation must complete an additional application with the CALS Registrar's Office.

3. Application to graduate. In the first semester of their senior year, students must complete and file an application to graduate with the CALS Registrar's Office.

Deadlines to File the Application to Graduate:

January graduates: September 14

May graduates: October 12

Failure to meet these deadlines could result in a student's name being omitted from the commencement program and/or a diploma not being available for pick-up on commencement Sunday.

Student Responsibilities: It is the student's responsibility to complete the application to graduate, obtain signatures from faculty advisor(s), and then schedule an appointment to file the application with the CALS Registrar's Office.

Faculty Advisor Responsibilities: It is the faculty advisor's responsibility to inform seniors of any courses still needed to fulfill major and/or minor requirements and to list those courses on the application to graduate. Faculty advisors must sign the application to graduate before the student meets with the CALS Registrar's Office. If a student is completing more than one major and/or a minor, the signatures of all faculty advisors are required.

CALS Registrar's Office Responsibilities: It is the responsibility of the CALS Registrar's Office to inform seniors of any credits needed to fulfill the CALS graduation requirements and to list those credits on the application to graduate. The Registrar's Office will sign the application to graduate and provide both the student and faculty advisor with copies of the signed application. The student should retain a record of the application.

Commencement Information:
Commencement information will be provided to all graduating seniors directly by the Commencement Office. Information is also available at www.commencement.cornell.edu/.

ACADEMIC POLICIES AND PROCEDURES

Registration

All students must register with the university at the beginning of each semester. In order to be considered a registered student by the university, a student must:

- complete course enrollment according to individual college requirements;
- settle all financial accounts, including current semester tuition;
- clear any holds, whether these are from the Bursar's Office, Gannett Health Center, the judicial administrator, or the dean of your college; and
- satisfy New York State health requirements.

Students can check their registration status using Just the Facts. The first screen in Just the Facts will indicate whether you are registered and will list any holds that need to be cleared, including the correct office to visit to have the holds removed.

Course Enrollment

Students will receive course enrollment information from the university registrar. After planning a schedule of courses in consultation with their faculty advisor, students pre-enroll by computer.

To enroll in courses that involve independent study, teaching, or research, a student must file an independent study form, available in the CALS Registrar's Office, 140 Roberts Hall.

Repeated Courses

Students may enroll again for a course in which they received a grade of F in a previous semester. Both grades will be recorded and calculated as part of their cumulative GPA. If a student retakes a course in which a passing grade was earned, both grades will be recorded and calculated as part of their cumulative GPA. However, repeating a course increases the number of credits required for graduation by the number of credits in the course.

Incompletes

Students must *not* enroll again for a course in which they received an incomplete. Instead, work for that course should be completed without further enrollment. The instructor files a manual grade form with the college registrar when a grade has been assigned. An incomplete not made up by the end of two successive semesters of residence reverts to a failure. In the case of a graduating senior, incompletes revert to failures at the time of graduation.

Enrollment Changes

A student is held responsible for and receives a grade for those courses in which he or she enrolls unless the student officially changes such enrollment. All changes in courses or credit, grading options, or sections must be made by the student using the online add/drop through "Just the Facts" or the official course drop and add form at the Registrar's Office, 140 Roberts Hall. Approval of the faculty advisor may be required to change course enrollment. Department or course instructor approval may be required for select courses.

Students may add courses and change grading options or credit hours where applicable during the first three weeks of the semester, and may drop courses until the end of the seventh week.

Academic Integrity Policy

The College of Agriculture and Life Sciences faculty, students, and administration support and abide by the university Code of Academic Integrity. Its principle is that absolute integrity is expected of every student in all academic undertakings: students must in no way misrepresent their work, fraudulently or unfairly advance their academic status, or be a party to another student's failure to maintain academic integrity.

The maintenance of an atmosphere of academic honor and the fulfillment of the provisions of the code are the responsibility of the students and the faculty. Therefore, all students and faculty members shall refrain from any action that would violate the basic principles of this code.

1. Students assume responsibility for the content and integrity of their submitted work, such as papers, examinations, or reports.
2. Students are guilty of violating the code if they
   - knowingly represent the work of others as their own.
   - use or obtain unauthorized assistance in any academic work.
   - give fraudulent assistance to another student.
   - fabricate data in support of laboratory or field work.
   - forge a signature to certify completion or approval.
   - submit the same work for two different courses without advance permission.
   - knowingly deprive other students of library resources, laboratory equipment, computer programs, or similar aids.
   - in any other manner violate the principle of absolute integrity.
3. Faculty members assume responsibility to make clear to students and teaching assistants specific regulations that apply to scholarly work in a discipline.
4. Faculty members fulfill their responsibility to
   - maintain in all class, laboratory, and examination activities an atmosphere conducive to academic integrity and honor.
   - make clear the conditions under which examinations are to be given.
   - make clear the consequences of violating any aspects of the code.
   - provide opportunities for students to discuss the content of courses with each other and help each other to master that content and distinguish those activities from course assignments that are meant to test what students can do independently.
   - state explicitly the procedures for use of materials taken from published sources and the methods appropriate to a discipline by which students must cite the source of such materials.
   - approve in advance, in consultation with other faculty members, which work submitted by a student and used by a faculty member to determine a grade in a course may be submitted by that student in a different course.
   - monitor the work and maintain such records as will support the crucial underpinning of all guidelines: the students' submitted work must be their own and no one else's.

Cornell's Code of Academic Integrity spells out how individuals who have allegedly violated Cornell standards for academic integrity are to be confronted and, if found to be in violation of those standards, sanctioned. The code provides informal resolution of most perceived violations through a primary hearing between the faculty member, the student involved, and an independent

witness. If necessary, a hearing before a hearing board follows.

The Academic Integrity Hearing Board for the College of Agriculture and Life Sciences consists of three elected faculty members, three elected student members, a chair appointed by the dean, and the director of counseling and advising, who serves as a nonvoting record keeper. Professor Dale Grossman is the current chair.

Individuals who observe or are aware of an alleged violation of the code should report the incident to the faculty member in charge of a course or to the chair of the hearing board. General information and details on procedures for suspected violations or hearings are available from the Counseling and Advising Office, 140 Roberts Hall.

Academic Honors

The college encourages high academic achievement and recognizes outstanding students in several ways:

1. **Dean's List.** Each semester, students are recognized for academic excellence by inclusion on the Dean's List. Eligibility for the Dean's List in the College of Agriculture and Life Sciences is determined by the following criteria:

a. a minimum course load for the semester of 12 letter-graded credits;

b. completion of at least one CALS course;

c. achievement of a semester GPA of at least 3.50; and

d. achievement of an S grade, or a C- or better grade in each course (including physical education), with no Incompletes. Dean's List will be granted retroactively if students meet all the requirements after successful course completion to make up INC grades.

2. **Bachelor of Science with Honors**

a. Students receiving a cumulative GPA of 4.00 or greater (based on the cumulative Cornell GPA) will graduate "summa cum laude."

b. Students receiving a cumulative GPA of greater than or equal to 3.75 and less than 4.00 (based on the cumulative Cornell GPA) will graduate "magna cum laude."

c. Students receiving a cumulative GPA of greater than or equal to 3.50 and less than 3.75 (based on the cumulative Cornell GPA) will graduate "cum laude."

3. **Bachelor of Science with Distinction in Research.** Students will graduate with a bachelor of science degree with distinction in research when, in addition to having completed all the graduation requirements, they have satisfactorily completed the research honors program in their area of interest and have been recommended for the degree by the honors committee of that area. Special requirements are given in the section on the Research Honors Program.

4. **Ho-Nun-De-Kah**, founded in 1929, is the undergraduate honor society of the College of Agriculture and Life Sciences. Members are recruited from the top 20 percent of the senior class and top 15 percent of the junior class. In keeping with the ideals of encouraging scholarship, leadership, and citizenship, members provide free tutoring and a variety of service activities to both the college and the community. Visit Ho-Nun-De-Kah's web site at www.hndk.org/.

5. **Golden Key** is an international honor society that recognizes and encourages scholastic achievement and excellence in all undergraduate fields of study. Juniors and seniors in the top 15 percent of their class are invited to membership. Visit Golden Key's web site at www.rso.cornell.edu/gkihs/.

Academic Standing

At the end of each semester, the Committee on Academic Achievement and Petitions reviews the records of those students who in any respect are failing to meet the academic requirements of the college or who persistently fail to attend classes. For students not making satisfactory progress, the committee takes appropriate action, including, but not limited to, issuing warnings, placing students on probation, granting students leaves of absence, advising students to withdraw, or suspending or expelling students.

Specifically, the committee considers as possible cause for action failure to attend and participate in courses on a regular basis or, at the end of any semester, failure to attain one or more of the following:

- semester GPA of at least 2.00
- cumulative GPA of at least 2.00
- satisfactory completion of 12 or more credits per semester
- reasonable progress toward completion of major and distribution requirements

In general terms, regular participation in course work with academic loads at a level sufficient to assure graduation within eight semesters and grades averaging C (2.00) or higher are prima facie evidence of satisfactory progress and good academic standing.

Petitions Procedures

The Committee on Academic Achievement and Petitions is a college committee of six faculty and two student members. On behalf of the faculty, the committee

- reviews, at the end of each semester and at other times as shall seem appropriate to the committee, the progress of students toward meeting graduation requirements.
- receives and acts on petitions from individual students asking for exceptions from particular academic regulations or requirements of the college, or for reconsideration of action previously taken by the committee.
- acts on readmission requests from persons whose previous enrollment was terminated by the committee.
- notifies the petitioner in writing of the action taken by the committee.

A petition for exemption from a college academic requirement or missed deadline may be filed by any student who has grounds for exemption. A petition is usually prepared with the assistance of a student's faculty advisor, whose signature is required. The advisor's recommendation is helpful to the committee. The committee reviews the written petition and determines whether there is evidence of mitigating and unforeseen circumstances beyond the control of the student that would warrant an exemption or other action.

Students wishing to withdraw from a course after the end of the seventh week must petition. Requests for course changes are approved only when the members of the committee are convinced that unusual circumstances are clearly beyond the control of the student. The committee assumes that students should have been able to make decisions about course content, total workload, and scheduling prior to stated deadlines. A grade of W (for "withdrawal") is recorded on the transcript if a petition to drop a course is approved after the end of the seventh week of classes, and if an approved drop results in fewer than 12 credits.

Forms are available in the Counseling and Advising Office, 140 Roberts Hall. Counselors are available to assist with the process.

Leave of Absence

A student taking a break from studies in a future semester or who finds it necessary to leave the university before the end of a semester should submit a written petition for a leave of absence. Such action serves as appropriate notification to university offices and corrects the student's transcript.

An approved leave is considered a voluntary interruption in study and holds the student's place in the college without requiring reapplication to the university. Voluntary leaves are issued in two ways: unrestricted for students in good academic standing (no restrictions placed on length of leave, or activities pursued, and simple notification by student of intent to return), and restricted (length of leave and activities pursued may be specified, and a petition to return must be approved by the Committee on Academic Achievement and Petitions).

Information and petition forms are available in the Counseling and Advising Office, 140 Roberts Hall.

Withdrawal

A student who wishes to leave the university permanently should file a petition for withdrawal. Such petitions are approved if the student is in good academic standing. Students who have withdrawn and who later decide to return must apply to the CALS Admissions Office.

MAJOR FIELDS OF STUDY

The college curriculum consists of 24 major program areas that reflect the departmental academic effort in the college. Faculty curriculum committees in each area identify a sequence of courses appropriate to all students studying in that field. Courses of study are designed to provide systematic development of basic skills and concepts as well as critical thinking. Opportunity for concentration in an area of particular interest is usually available.

Programs are planned with considerable flexibility, allowing students to prepare for careers, graduate work, professional opportunities, and the responsibilities of educated citizens. Course requirements in each program area are different, but all students must meet the minimum distribution requirements of the college.

Agricultural Sciences

Agriculture is an exciting and dynamic field involving a wide range of disciplines. The Agricultural Sciences major trains students to be broad thinkers who are scientifically skilled and knowledgeable about socioeconomic issues related to agriculture and the environment. This interdisciplinary program is for students wishing to pursue a general education in agriculture to prepare for careers that require knowledge of food systems and natural resources. Such careers may include the production and marketing of plant/animal foods, agricultural education in secondary schools, organic farming, cooperative extension, and crop consultation. By providing students with focused categories of courses from which to choose, the Agricultural Sciences program is designed to allow students to work with their advisor in developing a curriculum that best fits the needs of each individual. The program allows students to focus on one or two areas of concentration while gaining a broad exposure to the agricultural courses across the college.

All students are required to take the core courses in sustainable agriculture, soil science, and integrated pest management, as well as gain practical experience by completing an internship and a "hands-on" experiential learning capstone course addressing real problems in agricultural science. Concentrations requiring at least 12 credits are available in Animal Science, Applied Economics and Management, Education and Communication, Crop Production and Management, and Sustainable Agriculture.

Students graduating with an Agricultural Sciences major will be trained to address complex global agricultural issues of today and will have a knowledge base that leads to employment in a variety of fields. The required emphasis on one or two concentration areas also allows students to become experts in the area of agriculture that is most exciting to them.

Since students in the Agricultural Sciences program come from across the college, we create a family of students who take courses, study, learn, and discuss together as a group. We do this by organizing activities that facilitate learning in an interdisciplinary setting, such as inviting guest speakers from various sectors of the agricultural industry to lead discussions, offering professional development workshops to train students for the workforce, and hosting social events for students in the major. Opportunities are also available in research and outreach experiences, and in summer employment, which serve to enrich the students' practical experience.

Animal Sciences

The animal sciences program area offers a coordinated group of courses dealing with the principles of animal genetics, nutrition, physiology, management, and growth biology. Emphasis in subject matter is directed toward domestic animal species, dairy and beef cattle, horses, poultry, pigs, and sheep, while laboratory, companion, and exotic animal species are also included in research and teaching programs. The Department of Animal Science has extensive facilities for animal production and well-equipped laboratories and classrooms, including a teaching barn, in which students can gain practical experience in the care and management of large animals.

The program focuses on the application of science to the efficient production of animals for food, fiber, and pleasure and easily accommodates a variety of interests and goals. Beyond a core of basic courses (suggested minimum, 15 credits) students select production and advanced courses to fulfill an individually tailored program worked out in consultation with their advisors. In this way it is possible to concentrate by species as well as by subject matter (nutrition, physiology, growth biology, breeding, management). For each subject area, supporting courses in other departments are readily available and strongly encouraged. Many science-oriented students elect a program emphasizing supportive preparation in the physical and biological sciences appropriate to graduate, veterinary, or professional study following graduation. Dairy management is a popular program among students who may be preparing to manage a dairy business or enter a related career. Other students may elect a program oriented toward economics and business in preparation for a career in the poultry, dairy, meat-animal, horse, feed, or meats industry. These are examples of the flexibility within these programs that can be developed to meet a student's career interest related to animals.

It is recommended that students obtain appropriate fieldwork or animal experience during summers. Several special training opportunities exist for highly motivated students. Juniors and seniors whose academic records warrant it may, by arrangement with individual faculty members, engage in research (either for credit or honors) or assist with teaching (for credit). The Dairy Management Fellows Program offers an equally challenging but different type of experience for a select group of students.

Students declaring a minor in animal science will arrange for a formal academic advisor in animal science at least three semesters before graduating. It is expected that the minor will be satisfied by completing at least 12 credit hours of animal science courses (at least 6 of which must be taken at Cornell), the makeup of which will be determined in consultation with the advisor. For example, it is recommended that students completing the minor will assemble courses (or demonstrate having the equivalent from elsewhere) including some basic and applied biology of animals (anatomy, physiology, nutrition, genetics) along with a selection of intermediate or advanced offerings from the animal science curriculum. Satisfactory completion of minor requirements will be verified by the minor advisor's signature on the petition to graduate.

For information, contact Deloris Bevins in 149 Morrison Hall, dgb1@cornell.edu.

Applied Economics and Management

The Department of Applied Economics and Management (AEM) offers undergraduate programs of study in three broad areas: business, agribusiness, and applied economics.

AEM is home to Cornell's undergraduate general business degree. Here students can immerse themselves in finance, marketing, management, and business strategy courses, as well as take specialized courses in entrepreneurship, food industry management, and agribusiness. This highly selective program is accredited by AACSB International, the accrediting body for general business degree programs.

AEM also includes undergraduate specializations that focus on the economics of agriculture and the environment. All AEM courses stress the application of analytical skills, critical thinking, and economic theory to real-world business and public policy issues.

Ten (10) areas of specialization are offered in AEM.

Specializations: Students must choose at least one specialization, but may choose more than one. Note: courses may be used to satisfy both an AEM core requirement and a specialization requirement.

Accounting

Agribusiness Management

Applied Economics

Entrepreneurship

Environmental and Resource Economics

Finance

Food Industry Management

International Trade and Development

Marketing

Strategy

Minors

Through the Department of Applied Economics and Management, CALS students may complete a minor program of study in five different subject areas: Agribusiness Management and Finance, Business, Environmental and Resource Economics, Food Industry Management, or Applied Economics. These minors consist of between 18 and 20 credits of required courses. Students should contact the Department of Applied Economics and Management for more detailed information and to enroll in one of these minor programs of study. These minors are not open to students outside CALS. For those lacking time to incorporate all the business minor requirements during the regular school year, up to three of the required courses can be taken during Summer Session.

Atmospheric Science

Atmospheric science is the study of the atmosphere and the processes that shape weather and climate. The curriculum emphasizes the scientific study of the behavior of weather and climate, and applications to the important practical problems of weather forecasting and climate prediction. Students develop a fundamental understanding of atmospheric processes and

acquire skill and experience in the analysis, interpretation, and forecasting of meteorological events. All students are required to complete a minimum of three semesters of calculus, two semesters of physics, and a semester each of chemistry, computer science, and statistics.

Atmospheric science courses are offered through the Department of Earth and Atmospheric Sciences (EAS). The requirements for the B.S. in atmospheric science through the College of Agriculture and Life Sciences are as follows:

1. **Atmospheric science:**

a. EAS 341, 342, 352, 447, 451

b. See tracks listed below for additional required courses

2. **Mathematics, statistics, and computer science:**

a. MATH 111, 112, (192 or 213), 293

b. AEM 210 or equivalent

c. EAS 121/150 or equivalent

3. **Basic physical sciences**:

a. PHYS 207, 208, or equivalent

b. CHEM 206

4. **Tracks**

Operational required	Education required	Broadcasting required
EAS 250	EAS 131/133	EAS 131/133
EAS 296	EAS 250	EAS 250
EAS 456		EAS 296
EAS 470		EAS 470
		COMM 201
suggested	**suggested**	**suggested**
EAS 131/133	Courses in	EAS 268
EAS 268	(ASTRO, EAS)	minor in communication
EAS 331		minor in education
EAS 435		

Business required	Environmental required
EAS 131/133	CHEM 207–208
EAS 268	EAS 334
	EAS 457
suggested	**suggested**
minor in business	EAS 131/133
	EAS 250
	EAS 268
	EAS 302
	EAS 331
	EAS 435
	EAS 483

It is recommended that students who are interested in graduate study in atmospheric science should take additional courses in mathematics and physics.

A student may minor in atmospheric science by completing any four of the following EAS courses*: 131, 250, 268, 331, 334, 341, 342, 352, 435, 447, 451, 456, 457, 470, 651, 652 or 666.

*(two of the courses must be taken at Cornell.)

Courses satisfying the requirements for a major or minor in atmospheric science may not be taken S-U.

Biological Sciences

Biology is a popular subject at many universities for a variety of reasons: it is a science that is in an exciting phase of development; it prepares students for careers in challenging and appealing fields such as human and veterinary medicine, environmental sciences, and biotechnology; and it deals with the inherently interesting questions that arise when we try to understand ourselves and the living world around us. Many of the decisions we face today deal with the opportunities and problems that biology has put before us.

The major in biological sciences is available to students enrolled in either the College of Agriculture and Life Sciences or the College of Arts and Sciences. The Office of Undergraduate Biology in 216 Stimson Hall provides student services that are available to students from either college.

The biology major is designed to enable students to acquire the foundations in physical and life sciences necessary to understand modern biology and to pursue advanced studies in a specific area of biology. Programs of study include either general biology or one of the following concentrations: animal physiology, biochemistry, computational biology, ecology and evolutionary biology, genetics and development, insect biology, molecular and cell biology, microbiology, neurobiology and behavior, nutrition, plant biology, and systematics and biotic diversity. Students interested in the marine sciences should consult the Shoals Marine Laboratory office, G14 Stimson Hall, 255-3717, for academic advising. For more details about the biology curriculum see the section in this catalog on biological sciences or visit www.biology.cornell.edu. For details regarding the minor in biological sciences, please refer to the Biological Sciences section of this catalog.

Biological and Environmental Engineering

The Department of Biological and Environmental Engineering (BEE) offers majors in biological engineering and environmental engineering. BEE faculty and students address three great challenges facing humanity today: ensuring an adequate and safe food supply in an era of expanding world population; protecting and remediating the world's natural resources, including water, soil, air, biodiversity, and energy; and developing engineering systems that monitor, replace, or intervene in the mechanisms of living organisms. The undergraduate engineering majors in the Department of Biological and Environmental Engineering have a unique focus on biological systems and the environment that is realized through a combination of fundamental engineering sciences, biology, engineering applications and design courses, and liberal studies. The program leads to a bachelor of science degree in biological or environmental engineering, which is awarded jointly by the Colleges of Engineering and Agriculture and Life Sciences.

Engineering students take courses in mathematics, statistics, computing, physics, chemistry, basic and advanced biology, fundamental engineering sciences (solid mechanics, thermodynamics, fluid mechanics, and transport processes), engineering applications, and engineering design. They may select upper-level engineering courses in subjects that include bioprocessing, soil and water management, biotechnology applications, bioinstrumentation, engineering aspects of animal physiology, environmental systems analysis, and waste treatment and disposal. Students may further strengthen their programs by completing an engineering minor. Students preparing for medical school take additional lab-based courses in biology, biochemistry, and organic chemistry. Throughout the curriculum, emphasis is placed on communication and teamwork skills and collaborative problem-solving. **Specific course requirements and other information for the biological engineering major and the environmental engineering major are described in the College of Engineering section of this publication.** Further information is also available at the undergraduate program office in BEE Student Services, 207 Riley-Robb Hall, or at www.bee.cornell.edu/.

The department also offers technology concentrations in biological engineering technology and environmental engineering technology within the Interdisciplinary Studies Major in CALS. The technology concentrations emphasize technical applications of biological, environmental, physical, and life sciences. Students take courses in basic biological and physical sciences and mathematics, and choose electives in engineering and technology, agriculture, business, social sciences, and liberal studies.

Many engineering and technology students participate in undergraduate teaching and research, internships, independent study, project teams, and study abroad. Students should have a strong aptitude for the physical and life sciences and mathematics and an interest in the complex social issues that surround technology.

Career opportunities cover the spectrum of self-employment, private industry, public agencies, educational institutions, and graduate programs in engineering and science, as well as the professional fields like medicine, business, and law.

The living world is all around us and within us. The biological revolution continues and it has given rise to a growing demand for technical people who have strong math and science skills, who can communicate effectively, who are sensitive to the needs of people, and who are interested in the challenges facing society. The Department of Biological and Environmental Engineering is preparing the next generation to meet these challenges.

Specific course requirements for the engineering programs are found in the College of Engineering section of this book.

Specific course distribution requirements for the concentrations in biological engineering technology and environmental engineering technology include the following:

		Credits
1.	*Basic Subjects*	
	a. Calculus	8
	b. Chemistry	7
	c. Physics	8
	d. Computer applications	4
	e. Statistics or probability	3
	f. Introductory biological sciences*	6–8
	g. Written and oral expression*	9
	h. Social sciences and humanities*	12
	*Required of CALS majors.	
2.	*Advanced and Applied Subjects*	
	a. Five courses (15 credits) in the biological, environmental, or agricultural sciences	15
	b. Five courses (15 credits) in technology. Three courses from the list of approved technology courses.**	
	At least three courses total have to be in engineering at or above the 300 level.	
	One course must be chosen from the list of approved laboratory courses.**	
	The lab course cannot double count as one of the three required technology courses	15
	**Contact department for a list of approved courses.	
3.	*Electives*	
	Additional courses to complete College of Agriculture and Life Sciences requirements	
4.	*Total (minimum)*	*120*

For further details on the biological and environmental technology concentrations, contact the BEE department undergraduate programs office at 207 Riley-Robb Hall, 607-255-2173 or at www.bee.cornell.edu.

Biology & Society

The Biology & Society program area is designed for students who wish to combine the study of biology with perspectives from the social sciences and humanities. Many of the most critical social issues of our time, from the implications of genetic engineering to the impact of global climate change, have biological processes at their core. At the same time these issues are inherently social, involving complex relationships among people, institutions, laws, and beliefs. The Biology & Society field of study provides the skills and perspectives necessary to confront problems with biological, social, and ethical dimensions. In consultation with a faculty member, students are expected to select their courses in the field to meet their own goals and interests. For a description of the Biology & Society requirements and courses, see "Biology & Society" under the College of Arts and Sciences in this publication or visit www.sts.cornell.edu.

Students who elect Biology & Society as their major field of study graduate from Cornell with well-developed writing and analytical skills and a knowledge base that can lead to employment in a variety of fields. Many graduates have accepted positions as health counselors, writers, or policy analysts and researchers for government organizations, medical institutions, consumer or environmental groups, or scientific research institutes. Students have found that Biology & Society is also excellent preparation for professional training in medicine, law, and health services administration and for graduate programs in such fields as genetic counseling, nutrition, clinical psychology, public health, environmental studies, anthropology, sociology, and other related fields.

Admissions

Students in CALS may be admitted provisionally into this field of study when they apply to the college. Full admission depends on completing introductory biology and completing an application. Students transferring into this field of study will need to complete introductory biology and to submit an application during their sophomore year.

The application includes

1. a one- to two-page statement explaining the student's intellectual interests in Biology & Society and why it is consistent with his or her academic goals and interests.
2. a selected theme.
3. a tentative plan of courses fulfilling Biology & Society requirements, including courses taken and those planned.
4. a transcript of work taken at Cornell University and/or elsewhere, current as of the date of application.

The faculty admissions committee reviews applications twice a year, once each during the fall and spring semesters. A faculty advisor is assigned on admittance to the field. Approximately 60 faculty members from three colleges serve as advisors to Biology & Society students. The major program is coordinated for students in all colleges through the Biology & Society Office, 306 Rockefeller Hall, where students can get information, specific course requirements, and application forms. Faculty advisors are available to discuss the Biology & Society requirements.

Requirements for the program are listed below. A full description and listings of courses that satisfy the requirements can be obtained in 306 Rockefeller Hall or at www.sts.cornell.edu. See also "Biology & Society" in the College of Arts and Sciences section of this publication.

Biology & Society requirements:

1. Introductory biology (101–104, 105–106, or 107–108, or a 5 in AP biology)
2. College calculus (one course)
3. Ethics (one course)
4. Two social sciences/humanities foundation courses
5. Three biology foundation courses
6. One biology depth course
7. Statistics (one course)
8. Core course
9. Five theme courses (a coherent group of five courses relevant to the student's special interest in Biology & Society, including a senior seminar that serves as a capstone course for the program).

Students should develop their theme and select their courses in consultation with a member of the Biology & Society faculty. A list of the faculty is available in 306 Rockefeller Hall. Further information may be obtained at www.sts.cornell.edu.

Biometry and Statistics

Quantitative prediction and interpretation are increasingly essential components of biological, physical, and social sciences. Complex patterns, structures, and interactions raise fundamental and fascinating questions that can be addressed only using mathematical, statistical, and computational methods. The wealth of data that can be acquired using modern methodologies to address these questions, in turn, requires substantive quantitative approaches to make possible appropriate analysis and interpretation. Computational power, meanwhile, continues to increase exponentially, providing the means for sophisticated analysis of complex phenomena.

The Biometry and Statistics major, in the Department of Biological Statistics and Computational Biology, focuses on the application of statistical and mathematical techniques to the sciences. Biometry applies statistics and mathematics to problems with a biological component, as seen in agricultural, environmental, biological, and medical science. Statistics is concerned with quantitative aspects of scientific investigation: design, measurement, summarization of data, and reaching conclusions based on probability statements. Students with ability in mathematics and an interest in its applications will find this a rewarding and challenging major.

The work of an applied statistician or computational biologist can encompass research, teaching, consulting, and computing in almost any combination and in a wide variety of fields of application. Opportunities for employment are abundant in academics, government, and businesses ranging from large corporations to small firms; salaries are usually excellent. Experience gained through summer employment, undergraduate research, or work as an undergraduate teaching assistant is highly recommended. For further details on the Biometry and Statistics major/minor, please contact the Director of Undergraduate Studies, Professor Steven J. Schwager (1194 Comstock Hall) at sjs5@cornell.edu or go to www.bscb.cornell.edu.

Requirements for the Major (beyond the college requirements)

Ten (10) core courses: plus either the Statistics or the Statistical Genomics concentration. Only courses for which the student receives a grade of C- or better will count toward the major in biometry and statistics.

Core Courses:

BTRY 301 Biological Statistics I or

BTRY 601 Statistical Methods I

BTRY 302 Biological Statistics I or

BTRY 602 Statistical Methods II

BTRY 408 Theory of Probability

BTRY 409 Theory of Statistics

BTRY 495 Statistical Consulting

MATH 111 Calculus I

MATH 112 or 122 or 191 Calculus II

MATH 221 or 223 or 231 or 294 Linear Algebra

MATH 192 or 213 or 222 or 224 Multivariable Calculus

CS 100M Introduction to Computer Programming or

BEE 151 Introduction to Computing

Statistics concentration: Students must complete three (3) advanced courses in statistics, computer science, operations research, biology, and/or mathematics courses; below is a sample of such courses (for complete list, go to www.bscb.cornell.edu/ugrads06/):

BTRY 310 Statistical Sampling

BTRY 410 Multivariate Analysis

BTRY 482 Statistical Genomics

BTRY 483 Quantitative Genomics and Genetics

BTRY 484 Computational Genomics

BTRY 603 Statistical Methods III: Categorical Data Analysis

BTRY 604 Statistical Methods IV: Applied Design

NTRES 670 Spatial Statistics

CS 426 Computational Biology

OR&IE 361 and 462 Stochastic Processes

OR&IE 473 Empirical Finance

BIOPL 440 Phylogenetic Systematics

AN SC 420 Quantitative Animal Genetics

MATH 311 or 413–414 Introduction to Analysis

MATH 420 Differential Equations and Dynamical Systems

Statistical genomics concentration: Students must complete two (2) courses from BTRY 482 Statistical Genomics, BTRY 483 Quantitative Genomics and Genetics, and BTRY 484 Computational Genomics; BIOGD 281 Genetics; and in addition, they must complete one (1) course from the advanced courses previously listed (for complete list go to www.bscb.cornell.edu/ugrads06/).

Supplementary concentration: Each biometry and statistics major is strongly encouraged to supplement the required courses with a concentration in an area of interest to the student, consisting of a cohesive set of courses chosen by the student. It is the student's responsibility to develop this concentration, with advice from the faculty, particularly the student's faculty advisor. It will be helpful to discuss the selection of courses with the Director of Undergraduate Studies or Undergraduate Advising Coordinator of a department closely linked with the chosen concentration.

The Minor

A minor in biometry and statistics is available to all undergraduate students in CALS. To complete the program, students must submit a minor program of study form, available in 1198 Comstock Hall. Each student will retain a copy of the form and will be responsible for planning the minor program of study in conjunction with the advisor in the student's major and a BSCB faculty advisor. Students and advisors in other departments should contact the Director of Undergraduate Studies in the Department of Biological Statistics and Computational Biology if they have general questions about Biometry and Statistics courses or the minor. A BSCB faculty member will supervise and assist each minor in course selection.

Requirements for the minor

BTRY 301 Biological Statistics I or BTRY 601 Statistical Methods I

BTRY 302 Biological Statistics II or BTRY 602 Statistical Methods II

BTRY 408 Theory of Probability

BTRY 409 Theory of Statistics

MATH 111 Calculus I

MATH 112 or 122 or 191 Calculus II

MATH 192 or 213 Multivariable Calculus or

MATH 221–222 or 223-224 Linear Algebra and Multivariable Calculus

One (1) additional statistics elective:

BTRY 310 Statistical Sampling

BTRY 410 Multivariate Analysis

BTRY 482 Statistical Genomics

BTRY 483 Quantitative Genomics and Genetics

BTRY 484 Computational Genomics

BTRY 495 Statistical Consulting

BTRY 603 Statistical Methods III: Categorical Data Analysis

BTRY 604 Statistical Methods IV: Applied Design

ILRST 614 Structural Equations

NTRES 670 Spatial Statistics

A minimum of 31 credits is needed to complete the minor. Only courses for which the student receives a grade of C- or better will count toward the minor in biometry and statistics.

Communication

Communication majors at Cornell study communication in three main areas: science, media, and technology. Students gain a strong core in the theory of communication processes, including attitude, knowledge, and behavior change, public opinion, and information systems. They develop applied oral and written communication skills; they learn how communication systems work in society and in their personal and professional lives; they apply their understanding of communication to solving problems, sustaining the environment, reaching the public with new knowledge, and managing intricate networks of technologies.

Communication majors learn how

- communication influences attitudes, opinions, and behaviors.
- mass media work in our society.
- to use, evaluate, and design communication technologies.
- to apply their understanding of communication to solving problems in science, the environment, government, industry, health, and education.

The communication major is a program with a strong core of contemporary communication knowledge, theory, and practice.

Required freshman courses

Fall semester

COMM 101 Cases in Communication

Spring semester

COMM 130 Visual Communication

COMM 131 Writing about Communication

This set of courses provides students with a basic understanding of communication and communication processes.

Required sophomore courses

COMM 201 Oral Communication

COMM 282 Research Methods in Communication Studies

Two of the four Focus Area introductory courses:

COMM 220 Contemporary Mass Communication

COMM 245 Psychology of Social Computing

COMM 276 Cases in Communication and Social Influence

COMM 285 Communication in the Life Sciences

After completing the courses in the core curriculum, all majors take an additional 18 credits in communication distributed among advanced writing and presentation courses, electives, and focus area requirements. In consultation with their advisers, students concentrate in one of four defined focus areas appropriate to specific educational and career goals.

1. *Communication in the life sciences (CILS)*: Students focusing in CILS will investigate how communication influences public understanding of science, environmental, and risk-related issues. While exploring conceptual and theoretical issues, students will learn specific skills for communicating science, environmental, and risk information to a variety of audiences. Possible career paths include public information officer, science writer, environmental educator/outreach specialist, environmental or health-risk communicator, and business, legal, and other graduate study.
2. *Communication media studies (CMS)*: Students focusing in CMS will investigate the forces that shape media in contemporary society, investigating how what we see and hear comes to be. They will also analyze and understand the psychological, social, and cultural processes that are in turn affected by media, from politics to entertainment to news to the very question of what we understand as real about ourselves and true about the world around us. Students may pursue careers in the media

industries, in designing the laws and policies regarding media, in business, legal, or other graduate study, or in the service of making media better; most of all, they will be more informed and astute citizens in a highly mediated world.

3. *Communication and information technologies (CIT)*: Students focusing in CIT will explore the social and psychological dimensions of the design, use, and evaluation of communication and information technologies, how people form and manage impressions and relate to each other in cyberspace, the uses of language in online interaction, and how people coordinate work in virtual teams, as well as people's interface and information needs. Possible career paths include information systems designer, research analyst, user interface designer, software designer, usability specialist, technology writer, and business, legal, and other graduate study.
4. *Communication and social influence (CSI)*: Students focusing in CSI will use communication principles to analyze issues and situations involving groups, organizations and selected audiences to design, implement, and evaluate appropriate communication programs. Courses stress the positive, ethical, and effective uses of communication in human affairs. This focus area would be appropriate for students interested in using communication to bring about change at the individual and societal level. Possible career paths include public relations, marketing communications, polling, human resources, governmental affairs, and business, legal, and other graduate study.

Detailed information on the distribution of courses is available from the department.

In designing the communication major, the faculty of the department has considered students' need to understand contemporary research-based knowledge about communication as well as their need to be competent communicators in the workplace and in society at large.

Through the Department of Communication, CALS students may **complete a minor program of study in communication or a minor program of study in information science or both.**

The **minor in communication** consists of four required courses: COMM 101, 130, 201 and either 220, 245, 276, or 285; Students also complete three elective courses totaling 9 credit hours, at least two of which must be at the 300-400 level, excluding the advanced writing and presentation courses and COMM 303, 353, 405, 496, and 498.

The minor in information science is a cross-disciplinary program requiring one prerequisite statistics course, two courses from the information systems component area (primarily computer science), two courses from the human-centered systems component area (human-computer interaction and cognitive science), one course from the social systems component area (social, economic, political, and legal issues), and one additional course from any component area. A list of specific courses is available through the Department of Communication.

Students should contact the Department of Communication to enroll in either of these programs of study.

Crop and Soil Sciences

The Department of Crop and Soil Sciences provides instruction in the subject matter areas of crop science, soil science, environmental information science, and agronomy. Agronomy integrates the first three subjects and is a part of the Agricultural Sciences major. A specialization in crop science is a part of the plant science major. A focus on soil science is possible in two majors, the science of natural and environmental systems (SNES) or the science of earth systems (SES). The SNES major is a biophysical science–based major that addresses the interface of environmental science and human systems involved in environmental management. Within the SNES major, students can concentrate in agroecosystem science, environmental biology, environmental information science, and sustainable development. The SES major places emphasis on the basic disciplines of chemistry, physics, and mathematics.

A minor in crop management is also available for students with any major at Cornell University. In summary, it requires at least two courses and at least 7 credits in each of crop science (CSS 311, 312, 317, or 414) and plant protection (CSS 315, 444, ENTOM 241, or PL PA 301 or 401) plus at least three courses and at least 12 credits in soil science (CSS 260, 372, 412, 421 or 466). Equivalent transferred courses can be substituted. This minor helps prepare students for the Certified Crop Advisor examination, which provides an important credential for jobs in agriculture and environmental management.

A minor in soil science requires 15 credits in soil science, but an additional 12 credits in biological, physical, and earth sciences are recommended to qualify the student for the Civil Service classification as Soil Scientist (GS-0470). In addition to 15 credits in soil science, Civil Service classification as Soil Conservationist (GS-0457) requires 12 credits in natural resources and agriculture and 3 credits in applied plant science. The soil science minor is also available to students with any major at Cornell University and transfer credit can be used to meet requirements. Students wishing to pursue either the crop management or soil science minor should contact the Department of Crop and Soil Sciences (255-5459).

Development Sociology

Technological, economic, demographic, and environmental changes are social processes. Each has major impacts on individuals, social groups, societies, and the international order. At Cornell, development sociology students study these and other facets of social change in both domestic and international settings. The development sociology major provides an opportunity for in-depth study of the interactions among development processes, environmental and technological contexts, demographic structures and processes, and the institutionalized and grassroots social movements through which people seek change in these dimensions. Courses offered by the department cover topics such as: the impact of changes in agricultural systems on rural development and rural labor markets; community and regional development; environmental sociology; technology; the political economy of globalization; women in development; and ethnic stratification and integration. Most courses provide background in both domestic and international aspects of the subject matter. Students can develop a specialization with a domestic, international, or global emphasis by choosing appropriate elective courses. All students learn the theory and methodology of sociology and how to apply both to research and policy in their subject areas.

Majors in development sociology are required to successfully complete seven core courses: introductory sociology (D SOC 101), international development (D SOC 205), population dynamics (D SOC 201), methods (D SOC 313 or 314), theory (D SOC 301), social stratification (D SOC 370), and a course in statistics. Four additional development sociology courses are also required of all majors, at least two of which must be at the 300 level or higher. The elective courses allow students to focus their major on particular themes such as the sociology of development; the social processes linking the environment, population, and development; and more general areas such as ethnic and class stratification, social movements, social policy, and gender and development. In each of these focus areas, students can choose to concentrate on domestic or international situations. Students are encouraged to complement courses in the department with course work in the history and economics of development, area studies, and the policy sciences.

Recognizing that students are concerned with future career opportunities, the development sociology major emphasizes acquisition of skills as well as general knowledge in preparation for jobs or post-graduate study. Accordingly, students are expected to become involved in the application of theory, methodology, and principles and concepts in the analysis of practical problems. Development sociology offers degree programs at both the undergraduate and graduate levels (B.S., M.S., and Ph.D.). The department and graduate field are recognized as top programs in the area. The department is particularly well known for providing instruction in international as well as domestic aspects of community and rural development, environmental sociology, sociology of agriculture, population studies, and the interactions among these dimensions. Development sociology faculty are committed to both quality instruction and cutting-edge research programs.

An undergraduate student minor is required to successfully complete three core courses from Group 1: introductory sociology (D SOC 101), international development (D SOC 205), social indicators (D SOC 313), or social stratification (D SOC 370). A student minor is also required to complete at least one course from Group 2: theory (D SOC 301), statistical evidence (D SOC 302), inequality and development (D SOC 305), social movements (D SOC 311), environment and society (D SOC 324), social stratification (D SOC 370, cannot be used for Group 2 if selected for Group 1), or honors research (D SOC 380). One additional elective (any D SOC course) must be completed if only one course from

Group 2 is selected. Courses taken with an "S-U" option will not apply.

The department maintains strong ties with technical fields in CALS as well as with programs dealing with a range of issues of importance to international and domestic development. These include: the International Agriculture Program, the Biology and Society Program, the Cornell Institute for Social and Economic Research, the Center for the Environment, the Polson Institute for Global Development, the Community and Rural Development Institute, the Gender and Global Change Program, the Bronfenbrenner Life Course Institute, and the Center for International Studies. Nearly half of the department faculty is associated with one or more area and ethnic studies programs including the American Indian Program, Latino Studies Program, Asian American Studies Program, Southeast Asia Program, South Asia Program, Latin American Studies Program, East Asia Program, and the Institute for African Development. Department members also maintain working relations with faculty members in the Department of Sociology and social science units located in other colleges at Cornell. Students are encouraged to supplement their development sociology course work by electing courses in these other departments.

Education

The Department of Education builds on strong academic disciplines such as sociology psychology, anthropology, biological and political sciences, political thought, and philosophy, and is grounded in empirical and theoretical studies of educational practice in order to address education in diverse contexts and across the lifespan. The department has two foci to meet societal demands for teachers, researcher, and learners. The Learning, Teaching, and Social Policy (LTSP) concentration, which includes the Cornell Teacher Education Program (CTE), concentrates on teacher education in science, mathematics and agricultural science education, diversity, critical pedagogy, the study of school-age children and their families, and policy related to formal education. The Adult and Extension Education (AEE) concentration prepares scholars and practitioners for adult and extension education leadership and professional development roles in domestic and international community-based, non-formal, and formal organizations and focuses on community development and organizing, adult education, public scholarship, university extension/outreach, learning in adulthood, educational planning and program development, and international adult and extension education. These two programs of study, largely at the graduate level, prepare leaders who will both engage in professional practice and improve educational processes through their scholarship and practice. Our undergraduate program leads to provisional certification in agricultural science education. An undergraduate minor in education is also available for students across all colleges at Cornell. For the latest information on program developments, go to http://education.cornell.edu.

Adult and Extension Education (AEE). Creating a livable world requires more than just new knowledge and technology; it also requires sustained and expert practice in learning and education. The AEE program provides opportunities for graduate students to investigate participatory educational and organizing practices that link learning to the challenge of facilitating global sustainability. As public universities focus their research, teaching, and extension on domestic and global environmental, political, and social problems, the AEE program focuses on creating opportunities for critical reflection on adult, extension, and international education by connecting action and research. We seek to move beyond procedural questions of "how to do it" to critical institutional questions of who does and who should benefit from our adult, extension, and international educational work. The aim is to engage practitioners and graduate students in critical reflection on practice to create practical theory from and for action.

Participation in the AEE program helps scholars and practitioners prepare for adult and extension educational leadership and professional roles in domestic and international community-based, nongovernmental, and governmental organizational settings. Areas of expertise and inquiry include: participatory practices in research, community development, and adult education; public scholarship, university extension/outreach, and community organizing in the United States; international adult and extension education; learning in adulthood; educational planning and program development; continuing professional education; staff development; and health issues related to the education of adults.

Learning, Teaching, and Social Policy (LTSP). This program is designed to foster the development of educational leaders, researchers, and practitioners who approach issues and challenges in education from multiple perspectives, and seek to construct an integrated knowledge base upon which the practice of teaching, learning, and social policy is based. The impacts of implementation and practice are explored for creating new theories, approaches, and policies to improve teaching, learning, and community life.

Drawing on the dynamic nature of teaching and learning, this program challenges students to create and apply research-based, critically reflective analysis of cognitive, intellectual, personal, social, moral, and institutional dimensions of learning, teaching, and educational policy in a variety of contexts and at multiple governance levels. Students engage in critically reflective practice to address pressing problems and issues in formal and nonformal educational contexts across a variety of national and cultural settings.

The program is philosophically grounded in the perspective that learning and teaching is a lifelong process vital to individual development, the development of democratic communities, and the implementation of democratic values in educational policy and practice. Context, gender, social, and economic diversity underlie the design and implementation of curriculum, teaching and learning theory, and social interactions, and are lenses for examining educational practice, theory, and policy.

Faculty members and graduate students in research programs in Learning, Teaching, and Social Policy (LTSP) engage in research that investigates factors that contribute to scientific and quantitative literacy; curriculum design and evaluation in science, mathematics, and agricultural science; effectiveness of teacher professional development; educational policy in rural schools; and sociomoral development, action, and reflective thought in schools and communities. Our mission is to contribute to an educated, global society of leaders and citizens who are prepared to respond to emerging social, technological, and scientific issues, with ethical and critically reflective judgment.

The Cornell Teacher Education (CTE) program is a unique interdisciplinary cohort-based program that certifies teachers for secondary teaching in agricultural science, science, and mathematics. Students in the CTE program develop a solid mastery of their content areas and an understanding of the issues in education, and interact with and learn from each other. Undergraduates accepted into the CTE program major in a mathematics, agriculture, or science field in any Cornell college and complete a minor in education. With a CTE minor and a bachelor's degree, students can complete the Master of Arts in Teaching (MAT) in one year. CTE teachers are prepared as scholars of teaching and learning, able to help all their students achieve the scientific and quantitative literacy and ethical decision making skills needed for participation in a democracy.

Agricultural Science Education is taught at the middle and high school levels in New York State and nationally. Building on strong academic disciplines in the agricultural sciences, and with a solid grounding in the psychological, social, empirical, and theoretical bases of educational practice, the department offers two programs that lead to professional certification in Agricultural Science Education. The undergraduate degree in Agricultural Science Education and the agriculture option in the Master of Arts in Teaching are both offered under the Cornell Teacher Education umbrella. In addition, the undergraduate degree offers a non-certification option for persons with interests in instruction in non-school settings such as extension, 4-H, arboretums, and state and national parks. All three of these programs prepare educators for leadership and professional roles in the broad fields of agriculture and natural resources.

Minor in Education

The minor in education gives students a planned core of courses to provide them with an overview of education as a field. One option prepares students to move into the graduate segment of the Cornell Teacher Education (CTE) program. Other options provide preparation for admission into other graduate teacher certification programs or a background for professional venues such as extension, business, and industry. Any undergraduate student in the university may enroll subject to availability in courses required for the minor. Students who wish to pursue a minor in Education must complete and submit an application. Applications are available in 408 Kennedy Hall, the CALS Office of Academic Programs, or by e-mailing cu_teacher_ed@cornell.edu.

Effective College Teaching Series. The Center for Learning and Teaching, under the auspices of the Department of Education,

offers a series of courses, both credit and noncredit, for the improvement of teaching at Cornell, designed for Cornell faculty members and graduate students who are either currently teaching or intending to teach. For details, contact the Center for Learning and Teaching, 255–6130, or www.clt.cornell.edu.

Current offerings include:

EDUC 548(5480) Effective College Teaching
Spring and one-week summer session. 1–3 credits. For faculty and graduate students who intend to pursue an academic career.

EDUC 578(5780) ITADP Cross-Cultural Classroom Dynamics, Language, and Teaching Practicum
Fall and spring. 2 credits. For international graduate students who have, or will have, teaching assistantships.

EDUC 579(5790) ITADP Further Training for International Teaching Assistants
Fall and spring. Noncredit course for international teaching assistants who have completed EDUC 578 but need or desire continued work in classroom instructional and communication skills.

Graduate Teaching Development Workshops
Offered early in each fall and spring semester, this daylong series offers an array of workshops in teaching effectiveness, from teacher-student interactions to developing a teaching portfolio. Noncredit, open to all Cornell faculty members and graduate teaching assistants.

EDUC 620(6200) Internship in Education
Fall and spring. 1 credit. Prerequisite: CALS Graduate Student Professional Development Workshop. For CALS graduate teaching assistants or CALS teaching personnel who wish to extend their workshop experience through reflective practice and consultation with an instructional support specialist.

Entomology

The entomology curriculum provides students with a basic background in biological and natural sciences, with a special emphasis on the study of insects. Majors may pursue graduate studies in entomology or related sciences upon completion of the B.S. degree. Alternatively, students may immediately begin careers in various aspects of basic or applied insect biology, including integrated pest management, insect pathology, environmental assessment, medical or veterinary entomology, insect toxicology, apiculture, insect systematics, or insect ecology. Because of the diversity of career options, the major includes flexibility among the core requirements and electives that can be selected by students in consultation with their advisors.

Requirements

General Requirements for CALS (see Graduation Requirements for Bachelor of Science) Basic Science and Math Requirements

- One year of college mathematics, may substitute statistics or biometry, but must include one course in calculus
- One semester of physics (may need two depending on future plans)
- CHEM 206–208 or 207–208
- CHEM 257 (organic)
- Introductory biology (101–104 recommended, even if AP credit received)
- BIOGD 281 (genetics) or PL BR 225 (plant genetics)
- BIOEE 278 (Evolutionary Biology)
- Choose one of the following two courses:

  BIOEE 261 (Ecology and the Environment)

  BIOBM 330 or 331 (Principles of Biochemistry)

  (Choice depends on student interest in organismal vs. cellular/molecular aspects of biology)

Entomology Requirements (15–21 credits)

- ENTOM 212 Insect Biology – 4 cr
- Group A (core courses). Choose two of the following six courses:

  ENTOM 331/332 Insect Systematics—4 cr

  ENTOM 333 Larval Insect Biology—3 cr

  ENTOM 400 Insect Development—4 cr

  ENTOM 455 Insect Ecology—4 cr

  ENTOM 483 Insect Physiology—4 cr
- Two additional entomology courses from Groups A or B (see link to Entomology Course Spreadsheet for a complete list of entomology courses, www.entomology.cornell.edu)

Food Science

The food science program prepares students for careers in the food industry or research organizations and for graduate study in food science or related disciplines. Food scientists enjoy satisfying careers that help ensure the sustainable availability of a safe, nutritious, affordable, and high-quality food supply for people throughout New York State, the nation, and the world.

Students in the food science program can choose from one of four specialization options in the major: (1) food science; (2) food operations and management; (3) food biotechnology; or (4) enology. The first option meets the curriculum standards set by the Institute of Food Technologists (IFT), the premier professional society for food scientists, allowing students to compete for IFT scholarships and awards. Students choose an option based on their individual interests and career goals.

The first two years of the undergraduate food science program are intended to establish a solid background in the physical and biological sciences, math and statistics, and communication skills. Required courses include chemistry (introductory and organic), biology, microbiology, calculus, physics, first-year seminar, introductory food science courses, and nutrition. The last two years emphasize the application of these basic sciences and technology to the manufacturing, sensory evaluation, storage, distribution, and safety of foods and food ingredients. Examples of food science core courses include Food Engineering Principles, Physical Principles of Food Manufacturing, Food Safety Assurance, Food Chemistry, Sensory Evaluation of Foods, and Food Microbiology; many elective courses are offered as well. Students choose electives to satisfy both college distribution requirements and their individual interests within the major and beyond.

Students are also strongly encouraged to participate in undergraduate research supervised by a faculty member and/or complete an internship in a food company during their program of study. Most teaching faculty in the department also have active research programs and welcome participation by undergraduate students. Students may receive academic credit or wages for faculty-directed undergraduate research. Several food companies recruit on campus for their internship programs. These internships provide an excellent opportunity for students to gain hands-on experience in their chosen field of interest and to establish contacts for future employment. A modern food processing and development pilot plant, an operational dairy plant, and well-equipped laboratory facilities are available to support the teaching and research needs of undergraduates.

Enology and Viticulture. Students with primary interest in viticulture and secondary interest in enology (V/E) can enroll in the plant sciences degree program, with a concentration in horticulture and a specialization in Viticulture. For these students, plant sciences will be their "major," and their required courses in enology (offered within the Food Science program) will constitute a "minor" in Food Science with a concentration in enology.

Students with primary interest in enology and secondary interest in viticulture (E/V) can "major" in food science (with a concentration in enology) and a "minor" in plant sciences (with a concentration in Horticulture).

Students in either track will take many of the same courses during their two years and must satisfy the core degree-program requirements of their major and minor program, as well as the general requirements of the college. The curriculum will consist of course work in the basic sciences (e.g., chemistry, biology, microbiology) as well as advanced courses in plant and food sciences. In addition, students will be expected to participate in internships at vineyards and/or with wine makers.

The curriculum is designed to provide students with a strong background in the basic sciences, coupled with a thorough understanding of plant and food sciences as applied to viticulture and wine making. Elective courses can be taken in a variety of areas to support and expand the major.

Prospective students should contact the undergraduate coordinators in either the Department of Horticulture (viticulture option) or Food Science (enology option) for specific course requirements.

Information Science

Information Science (IS) is an interdisciplinary field that studies the design and use of information systems in a social context: the field studies the creation, representation, organization, application, and analysis of information in digital form. The focus of Information Science is on systems and their

use, rather than on the computing and communication technologies that underlie and sustain them. Moreover, Information Science examines the social, cultural, economic, historical, legal, and political contexts in which information systems are employed, both to inform the design of such systems and to understand their impact on individuals, social groups, and institutions.

The Information Science major organizes its courses into three area-based tracks:

- *Human-Centered Systems.* This area examines the relationship between humans and information, drawing from human–computer interaction and cognitive science.
- *Information Systems.* This area examines the computer science problems of representing, organizing, storing, manipulating, and accessing digital information.
- *Social Systems.* This area studies the cultural, economic, historical, legal, political, and social contexts in which digital information is a major factor.

Students must complete a set of 11 core courses: one introductory course, four courses in math and statistics, and two courses from each of the three IS areas. Students must also obtain depth in two tracks—a primary and a secondary track—that together best represent their interests. In particular, completion of the major requires four advanced courses from the selected primary track and three advanced courses from the secondary track.

Note: All INFO courses will count as in-college credit.

Requirements

Core (11 courses)

1. Introductory (one course):

   INFO 130 Introductory Design and Programming for the Web

2. Math and Statistics (four courses):
   - MATH 111 Calculus I
   - one course chosen from: MATH 171 Statistical Theory and Application in the Real World; H ADM 201 Hospitality Quantitative Analysis; AEM 210 Introductory Statistics; PAM 210 Introduction to Statistics; ENGRD 270 Basic Engineering Probability and Statistics; BTRY 301 Statistical Methods I; SOC 301 Evaluating Statistical Evidence; CEE 304 Uncertainty Analysis in Engineering; ILRST 312 Applied Regression Methods; ECON 319 Introduction to Statistics and Probability; PSYCH 350 Statistics and Research Design
   - either MATH 231 Linear Algebra with Applications or MATH 221 Linear Algebra
   - INFO 295 Mathematical Methods for Information Science

3. Human-Centered Systems (two courses):

   INFO 214 Cognitive Psychology

   INFO 245 Psychology of Social Computing

4. Information Systems (two courses):

   CS 211 Computers and Programming

   INFO 230 Intermediate Design and Programming for the Web

5. Social Systems (two courses):
   - either ECON 301 Microeconomics or ECON 313 Intermediate Microeconomic Theory
   - one course chosen from: INFO 292 Inventing an Information Society; INFO 355 Computers: From the 17th Century to the Dot.com Boom; or INFO 356 Computing Cultures

Where options in the core courses exist, the choice will depend on the student's interests and planned advanced courses for the selected primary and secondary tracks.

Tracks

Students must complete four advanced courses in their selected primary track and three advanced courses in their selected secondary track.

Courses taken to satisfy the core-course requirements may not be used to fulfill the track requirements.

All courses used toward the major must be taken for a letter grade.

Additional information on Information Science courses can be found below and in the CIS section of *Courses of Study*. Course information for all other courses in the major can be found in the relevant departments (e.g., AEM, CS, and S&TS).

1. Human-Centered Systems

   PSYCH 342 Human Perception: Applications to Computer Graphics, Art, and Visual Display*

   INFO 345 Human–Computer Interaction Design

   PSYCH 347 Psychology of Visual Communications

   PSYCH 380 Social Cognition*

   PSYCH 413 Information Processing: Conscious and Unconscious

   PSYCH 416 Modeling Perception and Cognition

   INFO 440 Advanced Human–Computer Interaction Design

   INFO 445 Seminar in Computer-Mediated Communication

   INFO 450 Language and Technology

   DEA 470 Applied Ergonomic Methods

   *Students who take PSYCH 342 may also count its prerequisite, PSYCH 205, toward the Human-Centered Systems primary/secondary track requirements. Similarly, students who take PSYCH 380 may also count PSYCH 280 toward the Human-Centered Systems primary/secondary track requirements. At most, one of PSYCH 205 or 280 can be counted toward the primary/secondary track requirements.

2. Information Systems

   INFO 330 Data-Driven Web Applications

   INFO 372 Explorations in Artificial Intelligence

   CS 419 Computer Networks

   LING 424 Computational Linguistics

   INFO 430 Information Retrieval

   INFO 431 Web Information Systems

   CS 432 Introduction to Database Systems

   CS 465 Introduction to Computer Graphics

   CS 472 Foundations of Artificial Intelligence

   LING 474 Introduction to Natural Language Processing

   OR&IE 474 Statistical Data Mining I

   CS 478 Machine Learning

   OR&IE 480 Information Technology

   CS 501 Software Engineering

   CS 513 System Security

   INFO 530 Architecture of Large-Scale Information Systems

   CS 578 Empirical Methods in Machine Learning and Data Mining

3. Social Systems

   INFO 204 Networks

   SOC 304 Social Networks and Social Processes

   INFO 320 New Media and Society

   AEM 322 Technology, Information, and Business Strategy*

   INFO 349 Media Technologies

   INFO 355 Computers: From the 17th Century to the Dot.com Boom

   INFO 356 Computing Cultures

   INFO 366 History and Theory of Digital Art

   ECON 368 Game Theory (formerly ECON 467)*

   INFO 387 The Automatic Lifestyle: Consumer Culture and Technology

   S&TS 411 Knowledge, Technology, and Property

   INFO 415 Environmental Interventions

   ECON 419 Economic Decisions Under Uncertainty

   INFO 429 Copyright in a Digital Age

   INFO 435 Seminar on Applications of Information Science

   OR&IE 435 Introduction to Game Theory*

   S&TS 438 Minds, Machines, and Intelligence

   INFO 444 Responsive Environments

   INFO 447 Social and Economic Data

   H ADM 474 Strategic Information Systems*

   ECON 476/477 Decision Theory I and II

   H ADM 489 The Law of the Internet and E-Commerce

   INFO 515 Culture, Law, and Politics of the Internet

*Only one of OR&IE 435 and ECON 368 may be taken for IS credit. Only one of AEM 322 and H ADM 474 may be taken for IS credit.

The Minor

A minor in Information Science is also available to students in AAP (Architecture and Planning students only), Arts and Sciences, CALS, Engineering, Hotel, Human Ecology, and ILR. The minor has been designed to ensure that students have substantial grounding in all three of the human-centered systems, information systems, and social systems areas. Detailed information about the minor can be found in the CIS section of *Courses of Study*. Students are also referred to www.infosci.cornell.edu/ugrad/concentrations.html for the most up-to-date description of the concentration and its requirements.

International Agriculture and Rural Development

International agriculture and rural development provides students with an understanding of the special problems of applying basic knowledge to the processes of agricultural development in low-income countries. The student typically specializes in a particular subject and works with an advisor to plan a program oriented toward international agriculture. The courses in international agriculture and rural development are designed to acquaint students with the socioeconomic factors in agricultural development, the physical and biological nature of tropical crops and animals, and the various world areas for which study programs exist.

Requirements

In addition to the college distribution requirements, students in international agriculture and rural development must take a minimum of 36 credits toward the major. A minimum of 7 credits in international agriculture and rural development (IARD) are required. The foreign language requirement for the IARD major is identical to that of the College of Arts and Sciences (see p. 422). Students are expected to complete an overseas field experience of a minimum of six weeks. The other courses recommended are drawn from a wide range of disciplines. The objective is to familiarize students with the many facets of agricultural development in low-income countries. Students are encouraged to take additional specialized courses in one of the other program areas of the college.

International Studies Minor

Preparing for leadership in an increasingly interconnected and dynamic world, CALS undergraduates need knowledge, skills, and attitudes that build "global competencies." The minor for CALS students not majoring in international agriculture and rural development will recognize an international concentration of course work and experiences.

Requirements

1. Four courses with significant international content, as recommended by students' major departments (two should be from CALS).
2. One semester of IARD 480 Global Seminar.
3. The foreign language requirement for the international studies minor is identical to that of the College of Arts and Sciences (see p. 427).
4. An approved overseas experience (exchange, study abroad program, internship, or faculty-led short course).

For more information, contact the academic programs coordinator in the International Programs Office, 255-3811.

Landscape Architecture

Landscape architecture focuses on the art of landscape design as an expression of the cultural values and the natural processes of the ambient environment. The program's unique place within the university promotes interaction among the areas of horticulture, environmental science, architecture, and city and regional planning.

The course of study prepares students for the practice of landscape architecture. The curriculum focuses on graphic communication, basic and advanced design methods, landscape history and theory, plant materials, construction and engineering technology, and professional practice. Design studios deal with the integration of cultural and natural systems requirements as applied to specific sites at varying scales. Projects may include garden design, parks design, housing design, historic preservation, environmental rehabilitation, and urban design.

Landscape architecture offers two professional degree alternatives: a four-year bachelor of science degree administered through the College of Agriculture and Life Sciences and a three-year master of landscape architecture degree administered through the Graduate School for those who have a four-year undergraduate degree in another field. Both of these degrees are accredited by the Landscape Architecture Accreditation Board (LAAB) of the American Society of Landscape Architects. The major in each degree is composed of core courses related to professional education in landscape architecture, a concentration in a subject related to the core courses, and free electives.

The department also offers a two-year master of landscape architecture advanced degree program administered through the Graduate School for those with accredited degrees in landscape architecture or architecture. The program entails core courses in the discipline and the development of a concentration in subject matter areas such as landscape history and theory, landscape ecology and urban horticulture, the cultural landscape, site/landscape and art, or urban design.

In addition, an undergraduate minor in cultural landscape studies is available for nonmajors.

Dual-Degree Options

Graduate students can earn a master of landscape architecture and a master of science (Horticulture) or a master of city and regional planning simultaneously. Students need to be accepted into both fields of study to engage in a dual-degree program and must fulfill requirements of both fields of study. Thesis requirements are generally integrated for dual degrees.

Study Abroad

The faculty encourages study abroad and has two formally structured programs. The *Denmark International Study* (DIS) program is available primarily to senior undergraduates and third-year graduate students in the fall semester and is administered through Cornell Abroad. The *Rome Program* is made available to undergraduates and graduate students through the College of Architecture, Art, and Planning.

Bachelor of Science Landscape Architecture Degree Sequence (Note: Each semester, the studio classes require payment of a supply and field trip fee, and all landscape architecture majors are required to pay an annual technology fee.):

First Year

Fall Semester	*Credits*
*LA 141 Grounding in Landscape Architecture	4
†Biological sciences elective	3
†Physical sciences elective	3
†Social sciences or humanities elective	3
†Written or oral expression elective	3
	16
Spring Semester	
*LA 142 Grounding in Landscape Architecture	4
†Biological sciences elective	3
†Social sciences or humanities elective	3
†Written or oral expression elective	3
‡Physical sciences elective	3
	16

Second Year

Fall Semester	
*LA 491 Creating the Urban Eden: Woody Plant Selection, Design and Landscape Establishment	4
*LA 201 Medium of the Landscape	5
†Biological sciences elective	3
†Social sciences or humanities elective	3
Historical studies	3
	18
Spring Semester	
*LA 202 Medium of the Landscape	5
*LA 315 Site Engineering I	3
*LA 492 Creating the Urban Eden: Woody Plant Selection, Design and Landscape Establishment	4
†Written or oral expression elective	3
†Physical sciences elective	3
	18

Third Year

Fall Semester	
*LA 301 Integrating Theory and Practice	5
*LA 316 Site Engineering II (second seven weeks)	2
**Concentration	3
‡Free electives	4
	14

Spring Semester

**Concentration	6
*Historical studies	3
*LA 318 Site Construction	5
Electives	2
	16

Fourth Year

Fall Semester

*LA 401 Advanced Synthesis: Project Design	5
**Concentration	3
†Social sciences or humanities elective	3
(Optional landscape architecture study abroad semester in Denmark or Rome)	11

Spring Semester

*LA 402 Integrating Theory and Practice II	5
**Concentration	3
*LA 412 Professional Practice	1
‡Free elective	2
	11

Summary of credit requirements

*Specialization requirements	58
†Distribution electives	39
‡Free electives	8
**Concentration	15
	120

Master of Landscape Architecture (M.L.A.) License Qualifying Degree

Requirements of the three-year M.L.A. curriculum include 90 credits, six resident units of satisfactory completion of the core curriculum courses, and a thesis or a capstone studio. (Note: Each semester, the studio classes require payment of a supply and field trip fee, and all landscape architecture majors are required to pay an annual technology fee.)

First Year

Fall Semester

	Credits
*LA 505 Graphic Communication I	3
*LA 501 Composition and Theory	5
*Historical studies	3
*LA 491 Creating the Urban Eden: Woody Plant Selection, Design and Landscape Establishment	4
	15

Spring Semester

*LA 502 Composition and Theory	5
*LA 492 Creating the Urban Eden: Woody Plant Selection, Design and Landscape Establishment	4
**Concentration	2
*LA 615 Site Engineering I	3
*Historical studies	3
	17

Second Year

Fall Semester

*LA 601 Integrating Theory and Practice	5
*LA 616 Site Engineering II	2
*Electives	2
**Concentration	6
	15

Spring Semester

*LA 602 Integrating Theory and Practice	5
*LA 618 Site Construction	5
*LA 590 Theory Seminar	3
**Concentration	3
	16

Third Year

Fall Semester

*LA 701 Urban Design and Planning	5
‡Free elective	2
**Concentration	4
*Historical studies	3
	14

Spring Semester

*LA 800 Master's Thesis in Landscape Architecture	9
or *LA 702 Advanced Design Studio	5
*LA 412 Professional Practice	1
‡Free elective(s)	2 or 6
Concentration LA 603	1
	13

Summary of credit requirements

*Specialization requirements	64 or 68
**Concentration	16
‡Free electives	6 or 10
	90

Master of Landscape Architecture Advanced Degree Program. The two-year master of landscape architecture (M.L.A./A.D.) program serves to broaden and enrich undergraduate education in design by providing an expanded educational experience to those who are technically skilled. Applicants must hold a bachelor's degree in landscape architecture or architecture from an accredited program. The objective of the two-year (M.L.A./A.D.) program is to develop specializations for individuals who may wish to teach, practice, or conduct applied research in landscape architecture.

Students admitted to the two-year M.L.A./A.D. program are required to complete 60 credits of course work as approved by the members of their graduate committee. For landscape architects, this must include at least two advanced studios, a graduate seminar, a concentration, and a thesis. For architects, the curriculum requires three advanced studios, two courses in plants and planting design, two courses in the history of landscape, two courses in site engineering, a seminar in design theory, a course in professional practice, a concentration, and electives.

Undergraduate Minor for Nonmajors

Students outside the professional program may choose the undergraduate minor (five courses, 15 credits) in cultural landscape studies to complement their major. A variety of courses consider the cultural landscape as an object, something to be studied for its own sake, and as a subject, as a means to understand society's relationship to natural systems. The study of cultural landscapes also includes perceptions of landscapes, cultural ideas and values, and visible elements. Direct inquiries to Professor A. Hammer, Department of Landscape Architecture, 440 Kennedy Hall.

Courses: choose five for a total of 15 credits

+LA 360 Pre-Industrial Cities and Towns of North America (3 credits) offered alternate years

+LA 261 Fieldwork in Urban Archaeology (4 credits)

+LA 262 Laboratory in Landscape Archaeology (3 credits)

LA 263 American Indians, Planners, and Public Policy (3 credits), offered alternate years

+LA 282 Photography and the American Landscape (3 credits)

+LA 418 Audio Documentary: Stories from the Land (3 credits)

+LA 483 Seminar in Landscape Studies (3 credits)

LA 497 Independent Study (1–5 credits)

LANAR 524 History of European Landscape Architecture (3 credits)

LANAR 525 History of American Landscape Architecture (3 credits)

LA 545 The Parks and Fora of Imperial Rome (3 credits)

LA 569 Archaeology in Preservation Planning and Design (3 credits)

LA 580 Landscape Preservation: Theory and Practice (3 credits)

+ Distribution elective

Natural Resources

As the number of humans living on the Earth surpassed six billion at the start of the 21st century, knowing how to conserve and manage well the Earth's remaining biological resources and natural environments takes on increasing importance and urgency. The field of natural resources sits squarely at the interface of science and policy, applied to these important conservation and environmental challenges. This is a biologically based major that focuses on the interface of nature (species, populations, communities, and ecosystems) with the human institutions involved in environmental conservation and management. The major's focus on biological resources (e.g., fisheries, wildlife, forests, and wetlands) includes issues of conservation and restoration of scarce species and their habitats, sustainable harvest of species of economic importance, management of invasive species and overabundant species, population dynamics in aquatic and terrestrial environments, ecosystem and watershed management, and mitigating the effects of human-induced changes on the environment.

The mission of the Department of Natural Resources, home of the major, is "to develop knowledge and facilitate learning to improve society's stewardship of natural resources and the environment." A commitment to

undergraduate education is a vital component of that mission. For more information see www.dnr.cornell.edu. The curriculum emphasizes the biology and ecology of natural systems, as well as the social science/human aspects of conservation challenges. The major allows students flexibility to pursue a variety of paths to understand the scientific, ethical, and societal basis for management and protection of natural resources and environments through the application of ecological principles and knowledge of societal needs.

The Future for Natural Resources Majors

Most students entering the major have a strong interest in the natural world and in contributing to greater harmony between humans and the environment. An undergraduate degree in natural resources gives students the concepts and tools needed to participate intelligently and effectively in decisions that determine the future of our environment, either as natural resources professionals or as informed citizens.

Career opportunities in natural resources are diverse. The major prepares students for graduate school or entry-level positions in natural resources and environmental management agencies at local, state, federal, and international levels, or for jobs in the private for-profit (e.g., environmental consulting firms) or nonprofit sectors. Many students ultimately pursue graduate studies in environmentally related fields including the biological, physical, and chemical sciences; forest, wetland, stream, wildlife, or fisheries management; and environmental law and public policy. Graduates often assume leadership positions in government, colleges and universities, national and international conservation organizations, environmental consulting firms, environmental divisions of private industry, and organizations involved in environmental education or communication.

Curriculum

Natural resources is a flexible major, and free electives can account for as many as 40 credits out of the total of 120 required for graduation. Students complete a set of courses in biology, ecology, chemistry, mathematics, economics, ethics, and written and oral expression; many of these courses also meet the college's distribution requirements for graduation. *Freshmen and sophomores* complete a series of four foundation courses in the major: Introduction to the Field of Natural Resources, Environmental Conservation, Introductory Field Biology, and People, Values, and Natural Resources. Juniors complete three core courses: Applied Population Ecology, General Ecology, and Natural Resources Management and Planning. These foundation and core courses introduce the critical environmental and natural-resource issues confronting society, and develop the conceptual and methodological tools that students will use in upper-division courses.

Juniors and seniors may specialize in one of three areas of concentration: applied ecology, resource policy and management, or environmental studies. Through course work in these concentrations, students gain an in-depth understanding of key principles, concepts, and practices. All students also have the flexibility to gain exposure to a wide variety of environment-related courses offered by Natural Resources and other departments throughout Cornell. Many students elect to conduct a research honors thesis.

Areas of Concentration within the Major

Applied ecology is designed as a foundation for those who wish to pursue careers or advanced study in science-based conservation or management of fish and wildlife populations and their habitats, conservation biology, control of invasive and overabundant species, watershed and landscape management, quantitative population dynamics, resource inventory and information management, global ecology, or applied ecology and biogeochemistry of forests and wetlands. This concentration also may interest students seeking a biologically based approach to environmental science or global studies. Students who select this concentration typically focus their course work in the areas of species biology and applied ecosystem ecology, including quantitative analysis of fish, wildlife, and plant populations, ecosystems, and landscapes. They complement their course work within the department with courses in other departments, such as Ecology and Evolutionary Biology, Microbiology, Geology, Crop and Soil Science, Atmospheric and Earth Sciences, Animal Sciences, and Plant Biology.

Resource policy and management provides a foundation for students who wish to pursue careers or advanced study in the human dimensions or policy aspects of natural resource conservation and management, natural resource and environmental law, environmental policy analysis, or environmental communication. Students who select this concentration typically focus on courses related to the development of environmental policy, management strategies for particular species or ecosystems, natural resource planning, resource economics, or programs in environmental communication and education. They complement their course work within the department with courses in other departments such as Government, Ecology and Evolutionary Biology, Development Sociology, Communication, Applied Economics and Management, City and Regional Planning, and Policy Analysis and Management.

Environmental studies is intended for those who wish to pursue a broad and synthetic approach to understanding and participating in (re)structuring the interactions between society and environment. The concentration's emphasis is on developing an ability to think critically about these interactions. Building on a foundation of courses required for the natural resources major, during years 3 and 4, each student will design a cohesive sequence of six upper-division courses with help from their departmental advisor. These six courses should include two courses from each of three categories: (1) natural science; (2) social science and analytic skills, e.g., economics, political economy, logic, computer programming, GIS, statistics; and (3) humanities, e.g., history, philosophy, literature, arts, foreign language. This self-defined environmental theme ensures development of specific competencies linked to personal and professional ambitions of the individual student. Example themes include environmental law, environmental education, "green" business, sustainable agriculture, and environmental communication. Students are expected to take advantage of internship, independent study, and honors thesis opportunities, as appropriate.

Research and Work Opportunities for Undergraduates

The department offers many opportunities for field-oriented studies, independent research, internships, and jobs. These include several field-based courses and access for research at the Arnot Teaching and Research Forest near Ithaca, the Little Moose Field Station in the Adirondacks, the Cornell Biological Field Station on Oneida Lake near Syracuse, and the Hubbard Brook Experimental Forest in New Hampshire, as well as numerous natural areas near campus. Part-time jobs in the research and extension programs of many faculty members offer students opportunities for career-related work experience. A research honors program is available for qualified students.

For a comparison of the natural resources major with other environmental majors, see www.dnr.cornell.edu/teaching/ugrad/faq/cals_env.pdf.

Nutritional Sciences

Nutritional sciences draws upon chemistry, biology, and the social sciences to understand complex relationships among human health and well-being, food and lifestyle patterns, food and agricultural systems, and social and institutional environments.

The program in nutritional sciences provides students with strong training in human nutrition in the context of an understanding and appreciation of the agricultural and life sciences. The program responds to the growing and important interrelationships among human nutrition and the agricultural and life sciences. Growing public interest in health and nutrition has placed new demands upon food producers, processors, and retailers. The problems of hunger and malnutrition in the United States and abroad require that nutritionists work with specialists in areas such as agricultural economics, food production, and development sociology. Advances in biotechnology provide researchers with new ways to understand human nutritional requirements and the regulation of human metabolism.

Nutritional sciences majors complete a core set of requirements and choose elective courses in the areas of their particular interest. The core curriculum includes introductory chemistry and biology, organic chemistry, biochemistry, physiology, and mathematics. Students complete five courses in nutritional sciences: NS 115 Nutrition, Health and Society; NS 245 Social Science Perspectives on Food and Nutrition; NS 345 Nutritional and Physicochemical Aspects of Foods; NS 331 Physiological and Biochemical Bases of Nutrition; and NS 332 Methods in Nutritional Sciences. In addition, students select a minimum of three advanced courses in nutritional sciences as well as elective courses in the broad areas of food production and processing, food and agricultural policy, the life sciences, environment and natural resources, communication, and education.

All majors have faculty advisors in the Division of Nutritional Sciences with whom they meet regularly. Advisors help students

plan course schedules and help find opportunities for special study or experiences outside the classroom.

Many students engage in laboratory or field research with a faculty member for academic credit. The research honors program is designed for academically talented students who are interested in research. Honors students conduct independent research projects under the guidance of a faculty member and prepare an honors thesis. Many students participate in field experiences for credit during the academic year or summer. Placements in laboratories, industries, or community agencies are possible.

The major in nutritional sciences can lead to many different career paths. By supplementing the core requirements with courses in different areas, students can prepare for jobs in industry, government, or community agencies in the United States or abroad. The major is excellent preparation for graduate study in a variety of fields.

The Division of Nutritional Sciences is affiliated with both the College of Agriculture and Life Sciences and the College of Human Ecology. Most of the division faculty members work in Savage Hall, Kinzelberg Hall, and Martha Van Rensselaer (MVR) Hall. In addition to housing offices, classrooms, and seminar rooms, these buildings contain research facilities, specialized laboratories, a human metabolic research unit, and computer facilities.

For additional information about the nutritional sciences program, contact the Division of Nutritional Sciences Academic Affairs Office, B21 Savage Hall, 255-4410, aadns@cornell.edu.

The minor in **nutrition and health** in the College of Agriculture and Life Sciences allows students to choose from courses concerned with economic influences on human nutrition, epidemiology and public health, food quality and food service management, human health and nutrition, nutritional biochemistry, and the psychological and social influences on human nutrition. The minor consists of NS 115 Nutrition, Health, and Society plus 9 credits of 200-level or above didactic NS courses. Enrollment is limited in some courses. Please check www.nutrition.cornell.edu/undergrad/calsminr.html for details.

Plant Sciences

Plant sciences prepares students for careers that meet the challenges of providing a safe, nutritious, and abundant food supply for a growing world population and using plants to enhance the beauty of our landscapes. It is a multidepartmental program administered by faculty in the Departments of Crop and Soil Sciences, Horticulture, Plant Biology, Plant Breeding and Genetics, and Plant Pathology, representing one of the strongest groups of plant scientists in the world. Students in the program share a common interest in learning about topics associated with plant growth and development in the broadest sense, but beyond that common thread, individual career goals vary widely. Some have their sights set on careers in applied agriculture, others plan to contribute to advancements of our knowledge by way of teaching or research, and still others see study in plant science as a stepping-stone to specialized training in business, government, or law. In addition to the college distribution requirements, Plant Science majors must take at least one course in each of several areas including botany, plant physiology, ecology, taxonomy/systematics, genetics, statistics, plant-pest interactions, crop production, and soil science, for a total of 40 credits.

Students who begin with well-defined interests or who identify certain areas of interest after several semesters of course work may choose a specialization within one of the five cooperating departments. Each specialization has additional requirements beyond the basic core courses. However, students who are uncertain about the breadth of their interests or who are seeking as much flexibility as possible may choose to design their course of study in plant sciences without declaring a specialization. Those students develop a strong background in plant science but have fewer required courses so that they can explore other areas of interest.

More than 140 courses that deal directly with some area of plant science are offered by the cooperating departments, and other courses relating to plant science are offered elsewhere in the university. There are also ample opportunities for internships, undergraduate teaching, and research experience. Qualified students, especially those expecting to go on for graduate degrees, are encouraged to avail themselves of such opportunities. Students who are planning to enter the work force immediately upon completion of the B.S. degree are encouraged to obtain practical experience. This may involve summer employment in research or in a plant production or maintenance related industry such as a lawn and tree care company, commercial greenhouse, nursery, orchard, vineyard or winery, botanical garden or arboretum, crop production farm, or with Cooperative Extension. Plant sciences faculty members also encourage students to avail themselves of opportunities to work and/or study abroad.

In addition to classrooms and laboratories in five buildings on the Cornell campus proper, research and teaching facilities adjacent to the campus are freely available to students for hands-on practice, technical training, independent research projects, and internships. These facilities include research orchards and vineyards, golf courses and a turf research facility, the Cornell Plantations (including arboretum and natural areas) and vegetable and field crop farms. Demonstration/research facilities in Aurora (Cayuga County), Geneva (Ontario County), Highland (Ulster County), Lake Placid (Essex County), Middletown (Orange County), Odessa (Tioga County), and Riverhead (Suffolk County) are also sites administered by departments in the Plant Sciences consortium and are available for undergraduate and graduate field study.

Crop science is a specialization that focuses on the major food and feed crops of the world, such as wheat, corn, rice, soybeans, and alfalfa. In addition to 15 credits in applied crop science, students in this program take at least 6 credits in plant protection (weed science, entomology, and plant pathology), and at least 6 credits in soil science. The crop science specialization can be focused on preparation for graduate school or be combined with a crop management minor for those planning to be certified crop advisors.

Enology and viticulture. The College of Agriculture and Life Sciences offers a curriculum in viticulture and enology within existing undergraduate B.S. degree programs in plant sciences and food science.

Students with primary interest in viticulture and secondary interest in enology (V/E) can enroll in the plant sciences degree program, with a concentration in horticulture and a specialization in viticulture. For these students, plant sciences will be their "major," and their required courses in enology (offered within the food science program) will constitute a "minor" in food science with a concentration in enology.

Students with primary interest in enology and secondary interest in viticulture (E/V) will "major" in food science (with a concentration in enology) and "minor" in plant sciences (with a concentration in Horticulture).

Students in either track take many of the same courses during their two to four years, and must satisfy the core degree-program requirements of their major and minor programs, as well as the general requirements of the college. The curriculum consists of course work in the basic sciences (e.g., chemistry, biology, microbiology) as well as advanced courses in plant and food sciences. In addition, students are expected to participate in internships at vineyards and/or with wine makers.

The curriculum is designed to provide students with a strong background in the basic sciences, coupled with a thorough understanding of plant and food sciences as applied to viticulture and wine making. Elective courses can be taken in a variety of areas to support and expand the major.

Prospective students should contact the undergraduate coordinators in either the Department of Horticulture (viticulture option) or Food Science (enology option) for specific course requirements.

Horticulture. Derived from the Latin word "hortus," meaning garden, horticulture is a blend of science and culture involving knowledge of plants grown in farms and gardens, parks and landscapes, and athletic and recreational facilities; indoor plants; greenhouse and nursery plant production; and crops used for wines, herbs and spices, medicinal purposes, and coffee and teas. The knowledge and skills essential to grow, maintain, process, and market horticultural plants are in high demand in a world increasingly concerned with environmental quality, recreation, and health.

The 40 faculty members in horticulture specialize in almost every aspect of horticultural science, with active research and outreach programs regionally, nationally and internationally.

Students choosing a concentration in horticulture must complete a minimum of 40 credits of core courses for the plant sciences major, plus the following courses:

HORT 101 Horticultural Science and Systems (4 credits)

HORT 400 Plant Propagation (3 credits)

Two HORT courses in plant production or management at the 400 level (6 credits)

One additional course of integrated pest management (plant pathology, entomology, or weed science) beyond the 3-credit plant sciences core requirement (3 credits)

Students transferring into Cornell from other colleges can petition to waive or adjust these requirements, in consultation with their faculty advisors.

Plant biology stresses a basic, rather than applied, understanding of how plants function, grow, and develop, as well as a study of their genome, evolution, and relationships to man. It provides undergraduates with a thorough preparation for graduate study in plant sciences. In cooperation with an advisor each student plans a curriculum with a concentration in basic sciences, supplemented by more advanced courses in plant biology. Students specializing in plant biology within the plant sciences major should take a minimum of four courses beyond the core of plant sciences courses. Options include plant molecular biology, plant cell biology, biochemistry, ethnobotany, and further courses in the function, growth, genetics, systematics, ecology, and evolution of plants. Individual research under professorial guidance is encouraged. Different options within plant biology afford a flexible curriculum.

Plant genetics and breeding relates information about genetics/genomics of plants to the improvement of cultivated plant species. Agriculturally important genes are identified, characterized, and deployed through combinations of molecular studies and sexual crosses. This area of study integrates genetic information with plant physiology/biochemistry, plant pathology, entomology, conservation biology, international agriculture, and related areas to create crops that meet the needs of modern society. In addition to the core plant sciences courses, students should take PL BR 201, 403, 404, and BIOPL 343. Other courses may be included after consultation with the advisor. Students are encouraged to participate in research projects and take advantage of opportunities for internships in industry.

Plant pathology is the study of plant diseases caused either by microorganisms or by chronic exposure to toxic elements in air and water. At the very least, specialists in the field must learn how to identify plant diseases and to design management strategies that will limit their overall impact. However, by employing contemporary tools from molecular biology, plant pathologists are also well positioned to answer fundamental questions about the nature of host–pathogen interactions and the genes that control them. Use of these new tools has already led to rapid deployment of disease-resistant crop varieties and it promises to offer much more in the future. For most students, a concentration in plant pathology as an undergraduate is preparation for graduate study in the field. However, graduates may also be employed as representatives with agribusiness firms, Cooperative Extension educators, state or federal regulatory agents, and laboratory technicians. Suggested courses beyond the plant sciences core include organic chemistry, biochemistry, calculus, introductory plant pathology, mycology, entomology, and plant breeding.

Plant protection is offered to students who are interested in the management of plant pests. It includes the study of insects, diseases, weeds, vertebrate pests, and other factors that prevent maximum crop production. Although designed as a terminal program for students desiring practical preparation for careers in pest management, the specialization can also provide an adequate background for graduate work in entomology, plant pathology, or weed science.

Science of Earth Systems (SES)

During the past several decades, with the increasing concern about issues such as air and water pollution, nuclear waste disposal, the destruction of the ozone layer, and global climate change, the scientific community has gained considerable insight into how the biosphere, hydrosphere, atmosphere, and lithosphere systems interact. It has become evident that we cannot understand and solve environmental problems by studying these individual systems in isolation. The interconnectedness of these systems is a fundamental attribute of the Earth system, and understanding their various interactions is crucial for understanding our environment.

The SES major emphasizes the basic study of the Earth system as one of the outstanding intellectual challenges in modern science and as the necessary foundation for the future management of our home planet. Cornell's strengths across a broad range of earth and environmental sciences have been fused to provide students with the tools to engage in what will be the primary challenge of the 21st century. The SES major has its home in the Department of Earth and Atmospheric Sciences, but includes collaboration with other departments across the university.

The SES curriculum includes a strong preparation in mathematics, physics, chemistry, and biology during the freshman and sophomore years. During the junior and senior years, students complete the SES core sequence, studying such topics as climate dynamics, Earth system evolution, biogeochemistry, and Earth's interior. These classes emphasize the interconnectedness of the Earth system. The selection of upper-level concentration courses allows the student to develop an area of expertise that complements the breadth of the introductory and SES core courses. Areas of concentration include biogeochemistry, geological sciences, and ocean sciences. Students may work with faculty advisors to develop other individually tailored concentrations.

The SES major provides a strong preparation for graduate school in any one of the Earth system sciences, such as atmospheric sciences, geology, geophysics, geochemistry, oceanography, hydrology, and biogeochemistry. Students seeking employment with the B.S. degree will have many options in a wide variety of environmentally oriented earth resource careers in both the private sector and government. Students with the strong science background provided by the SES major are also highly valued by graduate programs in environmental law, public affairs, economics, and public policy.

Requirements for the Major

1. Basic Math and Sciences

This part of the SES curriculum builds a strong and diverse knowledge of fundamental science and mathematics, providing the student with the basic tools needed in upper-level science classes.

   a. MATH 191–192 (or MATH 111–112)
   b. PHYS 207–208 (or PHYS 112–213)
   c. CHEM 207–208 or 207–257
   d. BIO G 101/103–102/104, or 105–106, or BIO G 109/110

2. Required Introductory Course:
   EAS 220 The Earth System

3. Science of Earth Systems Core Courses

These courses are founded on the most modern views of the planet as an interactive and ever-changing system, and each crosses the traditional boundaries of disciplinary science. Three courses selected from the following four core courses are required for the major.

EAS 301 Evolution of the Earth System

EAS 303/NTRES 303 Biogeochemistry

EAS 304 Interior of the Earth

EAS 305 Climate Dynamics

4. Concentration Courses

Four intermediate to advanced-level courses (300 level and up) that build on the core courses and have prerequisites in the basic sciences and mathematics courses are required. Note that additional basic math and science courses may be required as prerequisites for courses chosen for the concentration. The concentration courses build depth and provide the student with a specific expertise in some facet of Earth system science. The concentration should be chosen during the junior year or before in consultation with an SES advisor whose interests match those of the student. Four concentrations are defined for the major: biogeochemistry, geological sciences, ocean sciences, and climate dynamics (see EAS web site for details). Other concentrations can be tailored to a student's interests in concert with the student's advisor and upon approval of the SES curriculum committee. Examples include soil science, hydrology, and planetary science.

5. Field/observational/laboratory Experience

Exposure to the basic observations of earth science, whether directly in the field, or indirectly by various techniques of remote sensing, or in the laboratory, is necessary to understand fully the chosen area of concentration in the major. A minimum of 3 credits of course work of an observational nature is required. Possibilities include

Courses in the Hawaii Environmental Semester program;

Courses given by the Shoals Marine Laboratory;

EAS 250 (Meteorological Observations and Instruments);

EAS 352 (Synoptic Meteorology I);

EAS 417 (Field Mapping in Argentina);

EAS 437 (Geophysical Field Methods);

EAS 491 and/or 492 (Undergraduate Research, total 3 credits) with appropriate choice of project

Field courses taught by another college or university (3-credit minimum).

For more information, contact Professor Bryan Isacks, Department of Earth and Atmospheric

Sciences, bli1@cornell.edu, or visit www.eas.cornell.edu.

Science of Natural and Environmental Systems

Environmental stewardship and sustainability are increasingly recognized as human and planetary imperatives. This environmental science major will provide you with a strong foundation in the basic sciences, and an introduction to the relationships between the biophysical and social sciences. Concentrations include agro-ecosystem science, environmental biology, environmental economics, environmental information science, and sustainable development.

The curriculum comprises an intensive foundation in the sciences; an environmental core with courses covering earth, biotic, social, and economic systems; and several disciplinary programs of study. This major emphasizes inter- and multidisciplinary work, independent thinking and analysis, and development of competency in writing and speaking.

The SNES major is an excellent preparation for careers in governmental or non-governmental organizations responsible for environmental evaluation and policy; professional programs in law, business, journalism; and graduate programs in a variety of environmental science fields (earth science, ecology, environmental engineering, marine biology, soil science).

Foundation Courses

The purpose of this component of the program is to provide a strong foundation in the basic sciences and an introduction to the relationships between the biophysical and social sciences. Many of these courses (listed below) will also contribute to completion of CALS distribution requirements.

- two semesters of college-level biology
- two semesters of college-level calculus
- four semesters of college-level chemistry and physics (at least one semester of each)
- one semester of college-level statistics
- DEA 150 Introduction to Human-Environment Relationships
- NTRES 201 Environmental Conservation

The freshman and sophomore years are designed to provide a strong scientific basis for future advanced study and to become engaged in environmental studies through DEA 150 and NTRES 201. Depending on student interest and available time, other courses in environmental study may be taken as electives early in the schedule. Advanced placement credit will be accommodated in the program through consultation with the student's faculty advisor.

Environmental Core

The environmental core consists of six courses. Its purpose is to provide a rigorous, integrated understanding of the environment, broadly defined. This core recognizes that knowledge of the environment encompasses physical and biological sciences, social sciences, and human behavior. SNES 101, required in the freshman year, provides a unifying overview of the goals, depth, and breadth of the major.

Core courses are to provide integration (among areas, disciplines, methodologies, topics, and issues); systems emphasis; basic, rigorous presentation of core material; root competencies for understanding the environment; a framework for further advanced courses; and a new way of thinking that enables innovative solutions to difficult problems.

Biotic Systems: BIOEE 261 Ecology and the Environment

Colloquium Series: SNES 200 Environmental Sciences Colloquium

Earth Systems: CSS 365 Environmental Chemistry: Soil, Air, and Water

Economic Systems: AEM 250 Environmental and Resource Economics

Environmental Science: SNES 101 Intro to the Science and Management of Environmental and Natural Resources

Social Systems: D SOC 324 (S&TS/SOC 324) Environment and Society

Programs of Study

Programs of study that focus in one or more areas of environmental science have been established to provide disciplinary expertise sufficient for entry-level professional proficiency. Each student in the major will be required to take four courses at the 300 level or above in at least one program of study.

Programs of study do not replace or duplicate current majors. Rather, they provide the basic core of knowledge essential for an introductory understanding of the area—the concepts, basic science, methodologies, and major applications. Programs of study include

Agroecosystem Science

Environmental Biology

Environmental Economics

Environmental Information Science

Sustainable Development

For more information about this major, see http://snes.eas.cornell.edu, visit the undergraduate program office in 12 Fernow Hall, or send e-mail to sw38@cornell.edu.

Special Programs in Agriculture and Life Sciences

Interdisciplinary Studies. The opportunity to develop an independent major in interdisciplinary studies is available for students interested in pursuing a general education in agriculture and life sciences. In consultation with a faculty advisor, students may plan a sequence of courses suited to their individual interests, abilities, and objectives. In addition to the distribution and other college requirements, this major may include a concentration of courses in one of several academic units of the college or university. A course of study for a special program must be planned with and approved by a college faculty advisor. Information on the options and names of faculty advisors prepared to advise in special programs are available in the Counseling and Advising Office, 140 Roberts Hall.

DESCRIPTION OF COURSES

Undergraduate and graduate courses in the college are offered through the academic departments and units and also through the biological sciences undergraduate program and the Division of Nutritional Sciences.

Descriptions of undergraduate and graduate courses are arranged by department, in alphabetical order.

Graduate study is organized under graduate fields, which generally coincide with the departments. Graduate degree requirements are described in the *Announcement of the Graduate School*. Courses for graduate students are described in the section on the academic department that offers them.

INTERDEPARTMENTAL/INTERCOLLEGE COURSES

American Indian Studies

The American Indian Program offers a minor in American Indian Studies to undergraduate students. The minor is earned upon the completion of five courses: AIS 100 and AIS 101, plus at least three other courses from the AIS curriculum, for a minimum total of 15 credit hours. The three additional courses must include one course from Group A (arts and humanities) and one course from Group B (social and natural sciences) as listed below. One of the courses offered toward the minor must be at the 300- or 400 level. Only one 3-credit independent study (AIS 497) may be counted toward the minor. Only program-listed courses for which the student has earned a letter grade of C or better will be counted toward the minor. No courses taken for S-U credit will be counted toward the minor. Students seeking to minor in American Indian studies are encouraged to contact Professor Kurt Jordan, associate director of academic development, 255-3109. Application materials for the minor may also be obtained from the AIP office, 4th floor, Caldwell Hall. Students are also advised to consult www.aip.cornell.edu/academic.htm for the most up-to-date listings of course offerings.

Minor in American Indian Studies

Required Courses

AIS 100 Introduction to American Indian Studies I: Indigenous North America to 1890

AIS 101 Introduction to American Indian Studies II: Contemporary Issues in Indigenous North America

Electives

(Group A, Arts and Humanities)

AIS 195 Colonial Latin America

AIS 236 Native Peoples of the Northeast

AIS 239 Seminar in Iroquois History

AIS 260 Introduction to Native American Literature

AIS 266 Introduction to Native American History

AIS 364 Politics of "Nations Within"

AIS 386 Contemporary American Indian Fiction of the United States

AIS 404 Race and Ethnicity in Latin America

AIS 430 Native American Philosophies

AIS 486 American Indian Women's Literature

AIS 490 New World Encounters, 1500–1800

(Group B, Social and Natural Sciences)

AIS 230 Cultures of Native North America

AIS 235 Archaeology of North American Indians

AIS 311 Social Movements

AIS 340 Contested Terrain: Hawaii

AIS 348 Iroquois Archaeology

AIS 353 Anthropology of Colonialism

AIS 400 Critical Approaches to American Indian Studies

AIS 460 Field and Analytical Methods in American Indian Archaeology

AIS 472 Historical Archaeology of Indigenous Peoples

AIS 475 Governmentality, Citizenship, and Indigenous Political Theory

(Independent Study)

AIS 497 Independent Study

J. Mt. Pleasant, director; C. Andronicos, E. Cheyfitz, L. Donaldson, C. Geisler, A. Gonzales, K. Jordan, J. Parmenter, T. Richardson, J. Rickard, A. Simpson

AIS 100(1100) Introduction to American Indian Studies I: Indigenous North America to 1890 (CA) (HA) (D)
Fall. 3 credits. E. Cheyfitz.
Provides an interdisciplinary introduction to American Indian cultures and histories from Precolumbian times to 1890, emphasizing the current relevance of traditional values and the ways the deep past continues to affect present-day Indian peoples. Course materials draw on perspectives from the humanities, social sciences and expressive arts.

AIS 101(1110) Introduction to American Indian Studies II: Contemporary Issues in Indigenous North America (CA) (HA)
Spring. 3 credits. T. Richardson.
Interdisciplinary exploration of contemporary issues in American Indian Country north of Mexico after 1890. Examines Indian sovereignty, nationhood, agency, and engagement through time using the perspective of American Indian Studies. Course materials are drawn from the humanities, social science, and expressive arts.

AIS 195(1950) Colonial Latin America (also HIST 195[1950]) (CA) (HA)
Fall. 4 credits. S-U or letter grades. K. Graubart.
For description, see HIST 195.

AIS 230(2300) Cultures of Native North America (also ANTHR 230[2730]) (CA) (HA) (D)
Fall. 3 or 4 credits. Staff.
For description, see ANTHR 230.

AIS 235(2350) Archaeology of North American Indians (also ANTHR 235[2235]) (CA) (HA) (D)
Spring. 3 credits. K. Jordan.
For description, see ANTHR 235.

AIS 236(2360) Native Peoples of the Northeast, Pre-Contact to the Present (also HIST/AM ST 236[2360]) (CA) (HA) (D)
Spring. 4 credits. J. Parmenter.
For description, see HIST 236.

AIS 239(2390) Seminar in Iroquois History (also HIST 239[2390]) (CA) (HA)
Fall. 4 credits. J. Parmenter.
For description, see HIST 239.

[AIS 260(2600) Survey of American Indian Literatures in the United States (also ENGL 260[2600]) (LA) (CA) (D)
Spring. 4 credits. Next offered 2009–2010. E. Cheyfitz.
For description, see ENGL 260.]

AIS 266(2660) Introduction to Native American History (also HIST/AM ST 266[2660]) (CA) (HA)
Spring. 4 credits. J. Parmenter.
For description, see HIST 266.

[AIS 311(3110) Social Movements (also D SOC/LSP 311[3110]) (D)
Fall. 3 credits. Prerequisites: D SOC/SOC 101 or permission of instructor. S-U or letter grades. Next offered 2010–2011. A. Gonzales.
Social movements are collective efforts by relatively powerless groups of people to change society. Typically conceptualized as political activity outside the institutional framework, social movements are "politics by other means." This course examines the transnational dimensions of social movements to assess the implications of globalization for political mobilization and the ways that social movement actors engage the global political process to effect social change. Under what circumstances do movements emerge? How do global processes shape both domestic and transnational political mobilization? How do movements internally organize and choose political tactics and strategies to achieve their goals? How have social movements changed history, identities, society, and politics? This course addresses these and related questions through an examination of indigenous peoples' movements in the United States, Canada, and Latin America.]

AIS 340(3400) Contested Terrain: Hawaii (also SOC 342[3420]) (CA) (SBA)
Spring. 3 credits. Prerequisite: introductory or intermediate-level social sciences or history. M. M. Hamabata.
This course, offered in conjunction with Earth and Atmospheric Sciences' program in Hawaii, draws from the fields of history, political science, and sociology to present an historical understanding of contemporary Hawaiian society. Topics include Western contact, establishment of Western institutions, overthrow of a sovereign government, annexation, integration into the United States. Direct experience with Hawaiian leaders and institutions are incorporated to address contemporary issues: sovereignty, economic development/dependency, social change, and land use as a sociopolitical and cultural struggle. Students should consult www.eas.cornell.edu/hawaii/ regarding the status of this course.

[AIS 348/648(3480/6480) Iroquois Archaeology (also ANTHR 348/648[3480/6480]) (CA) (HA)
Fall. 4 credits. S-U or letter grades. Next offered 2008–2009. K. Jordan.
For description, see ANTHR 348/648.]

AIS 353(3530) Anthropology of Colonialism (also ANTHR 353[3453]) (CA) (SBA) (D)
Fall. 4 credits. A. Simpson.
For description, see ANTHR 353.

AIS 364(3640) Politics of "Nations Within" (also GOVT 364[3640]) (SBA) (KCM)
Spring. 4 credits. Letter grades only. Offered alternate years. B. Hendrix.
For description, see GOVT 364.

[AIS 386(3860) Contemporary American Indian Fiction (also ENGL 367[3670]) (LA) (CA) (D)
Fall. 4 credits. Next offered 2010–2011.
Examines contemporary American Indian fiction as a response to the colonial structure of federal Indian law. Beginning with Mourning Dove's *Cogewea*, a novel of the Allotment Era, students read works by a range of Native fiction writers (from a list that includes McNickle, Welch, Silko, Vizenor, Hogan, Alexie, Walters, Glancy, and Red Corn) that respond critically to U.S. federal Indian policy.]

AIS 400(4000) Critical Approaches to American Indian Studies (also AIS 600[6000]) (CA) (HA)
Fall. 4 credits. Prerequisite: advanced undergraduates or graduate students; permission of instructor. Course requirements differ at 400 and 600 levels. S-U or letter grades. A. Simpson.
This course is an interdisciplinary survey of the literature in Native American Studies. Readings from this course engage themes of indigeneity, coloniality, power, and "resistance." The syllabus is formed from some of "classic" and canonical works in Native American Studies but also requires an engagement with marginal writings and theoretical and historical contributions from scholars in other disciplines.

[AIS 404(4040) Race and Ethnicity in Latin America (also HIST 404[6041]) (CA) (HA)
Fall. 4 credits. Recommended: Latin American history course. Next offered 2010–2011. K. Graubart.
For description, see HIST 404.]

[AIS 430(4300) Native American Philosophies (also ENGL/AM ST 430[4300]) (KCM) (LA)
Fall. 4 credits. Prerequisite: permission of instructor. Next offered 2009–2010. E. Cheyfitz.
This course will focus on American Indian, Native Alaskan, and Native Hawaiian social, spiritual, legal, political, aesthetic, scientific, environmental, and historical thought from the pre-invasion period (before 1492) to the present as it is contained in both oral narratives and written texts (nonfiction, fiction, and poetry).]

AIS 460(4600) Field and Analytical Methods in American Indian Archaeology (also ANTHR/ARKEO 460[4260]) (SBA) (HA)
Spring. 6 credits. Prerequisite: permission of instructor. K. A. Jordan.

This course uses historic-period American Indian sites in the Finger Lakes region to provide hands-on instruction in archaeological field, laboratory, and analytical methods. Students will analyze museum artifacts and engage in field survey and excavation. Readings treat field and laboratory methodology, research design, culture history, and material culture typologies.

[AIS 472/772(4720/7720) Historical Archaeology of Indigenous Peoples (also ANTHR/ARKEO 4272/7272 (CA) (HA)
Fall. 4 credits. Next offered 2009–2010. K. A. Jordan.
Seminar examining the responses of indigenous peoples across the world to European expansion and colonialism over the past 500 years. Archaeological case studies from North America, Africa, and the Pacific provide a comparative perspective on Postcolumbian culture contact and illustrate how archaeology can both supplement and challenge document-based histories.]

AIS 475(4750) Governmentality, Citizenship, and Indigenous Political Theory (also ANTHR 475[4750]) (CA) (KCM)
Spring. 4 credits. A. Simpson.
For description, see ANTHR 475.

[AIS 486(4860) American Indian Women's Literature (also ENGL 486[4860]) (LA) (CA) (D)
Spring. 4 credits. Next offered 2010–2011.
For description, see ENGL 486.]

[AIS 490(4900) New World Encounters, 1500 to 1800 (also HIST 490[4990], AM ST 499[4990]) (CA) (HA) (D)
Spring. 4 credits. Next offered 2008–2009. J. Parmenter.
For description, see HIST 490.]

AIS 497(4970) Independent Study
Fall or spring. 1–4 credits. Staff.
Topic and credit hours TBA between faculty member and student. The American Indian Program office must approve independent study forms.

AIS 600(6000) Critical Approaches to American Indian Studies (also AIS 400[4000]) (D)
Fall. 4 credits. A. Simpson.
For description, see AIS 400.

AIS 601(6010) American Indian Studies Proseminar
Fall and spring. 1 credit. Staff.
Graduate-level course that introduces students to ongoing research in the field of American Indian Studies in a proseminar/colloquium format. Advanced graduate students are expected to present their work in progress; all are expected to attend each seminar and provide presenters with critical and constructive commentary on papers.

AIS 635(6350) Indigenous Peoples and Globalization (also D SOC/LAT A 635[6350]) (D)
Fall. 3 credits. A. Gonzales.
Explores ways in which processes of globalization affect indigenous peoples worldwide and the strategies indigenous peoples are using to deal with those pressures. Globalization, whether under the auspices of the World Trade Organization and regional economic agreements such as the NAFTA or the deterritorialization of social and political arrangements cotemporal with modernization or the expansion of communication technology and its impact on traditional knowledge systems, have had profound social, cultural, and economic impacts on indigenous peoples. At issue are the lands, resources, traditional knowledge, intellectual and cultural property, and indigenous struggles for recognition and self-determination.

[AIS 661(6610) Colonial American Literatures (also ENGL/AM ST 661[6610])
Spring. 4 credits. Next offered 2009–2010. E. Cheyfitz.
For description, see ENGL 661.]

AIS 671(6710) Law and Literature in the Antebellum United States (also ENGL 671[6710])
Spring. 4 credits. E. Cheyfitz.
For description, see ENGL 671.

Department of Statistical Science

The university-wide Department of Statistical Science coordinates undergraduate and graduate study in statistics and probability. A list of suitable courses can be found in the CIS section of this catalog.

Environmental Toxicology

B. A. Ahner, A. J. Baeumner, K. W. Beyenbach, S. E. Bloom, K. J. Boor, P. R. Bowser, D. L. Brown, J. W. Casey, R. R. Dietert, R. A. Durst, J. W. Gillett, A. G. Hay, A. Hedge, J. H. Hotchkiss, L. V. Kochian, W. L. Kraus, A. T. Lemley, L. W. Lion, R. H. Liu, E. L. Madsen, M. B. McBride, C. McCormick, A. Nikitin, B. U. Pauli, R. Richardson, M. Roberson, E. Rodriguez, J. G. Scott, M. L. Shuler, S. M. Snedeker, D. A. Soderlund, J. R. Stedinger, B. J. Strupp, O. K. Vatamaniuk, D. A. Weinstein, R. S. Weiss, D. B. Wilson, A. Yen

There is both breadth and depth in many facets of environmental toxicology and related disciplines. The program offers a combination of research and didactic training that is designed to prepare students for solving the problems of modern toxicology. The graduate student may choose from three degree options: M.S., M.S./Ph.D., or Ph.D. Concentrations include cellular and molecular toxicology; nutritional and food toxicology; ecotoxicology and environmental chemistry; and risk assessment, management, and public policy. Research by the faculty associated with the program focuses on the interactions of drugs, pesticides, and other potentially hazardous environmental agents with a wide variety of living organisms (including humans) as well as the ecosystems with which these organisms are associated. General information is available through the Environmental Toxicology office in 116 Stocking Hall, or at toxicology.cornell.edu.

TOX 370(3700) Pesticides and the Environment (also ENTOM 370[3700])
Fall. 2 credits. Prerequisites: BIO G 101–102 or equivalent. Offered even-numbered years. J. G. Scott.
For description, see ENTOM 370.

TOX 437(4370) Eukaryotic Cell Proliferation (also BIOBM 437[4370])
Fall. Variable credit; students may take lec for 2 credits, or lec and disc for 3 credits. Limited to 20 students per disc; priority given to graduate students. Prerequisite: BIO G 101–102 or 105–106 and BIOBM 330 or 331/332. Recommended: BIOGD 281 and BIOBM 432. S. Lee.
For description see BIOBM 437.

TOX 490(4900) Insect Toxicology and Insecticidal Chemistry (also ENTOM 490[4900])
Spring. 3 credits. Prerequisite: general chemistry course. Offered odd-numbered years. J. G. Scott.
For description, see ENTOM 490.

TOX 597(5970) Risk Analysis and Management (also CEE 597[5970])
Spring. 3 credits. Prerequisite: introduction to probability and statistics course (e.g., CEE 304, ENGRD 270, ILRST 210, BTRY 261 or AEM 210); two semesters of calculus. Prerequisite: senior or graduate standing or permission of instructor. J. R. Stedinger.
For description, see CEE 597.

TOX 610(6100) Introduction to Chemical and Environmental Toxicology (also BIOMI 610[6100])
Fall. 3 credits. Prerequisite: graduate standing in field or permission of instructor. A. G. Hay.
For description, see BIOMI 610.

TOX 611(6110) Molecular Toxicology (also NS 611[6110])
Spring. 3 credits. Prerequisites: TOX 610 or permission of instructors. Offered alternate years. S. Bloom, R. Dietert, D. Muscarella, and B. Strupp.
For description, see NS 611.

TOX 698(6980) Current Topics in Environmental Toxicology (also NS 700[7000])
Fall, spring. 1 to 3 credits. Prerequisites: graduate or senior standing in scientific discipline and permission of instructor.

TOX 699(6990) Environmental Toxicology Journal Club (also BIOMI 699[6990])
Spring only. 1 credit. Requirement for env. tox. students until post–A exam. A. G. Hay.

TOX 701(7010) Mouse Pathology and Transgenesis (also VTBMS 701[7010])
Spring only. 1 credit. Prerequisites: basic course in histology (BIOAP 413 or equivalent) highly recommended, or permission of instructor. Letter grades only. A. Nikitin.
For description, see VTBMS 701.

TOX 702(7020) Seminar in Toxicology (also NS 702[7020])
Fall or spring. 1 credit.
For description, see NS 702.

TOX 713(7130) Cell Cycle Analysis (also VTBMS 713[7130])
Spring. 1 credit. S-U grades only. Offered alternate years. A. Yen.
For description, see VTBMS 713.

TOX 890(8900) Master's Thesis and Research
Fall/spring. Credit TBA. Prerequisite: permission of chair of graduate committee and instructor.

TOX 990(9900) Doctoral Thesis and Research
Fall/spring. Credit TBA. Prerequisite: permission of chair of graduate committee and instructor.

Related Course in Another Department

FD SC 621(6210) Food Lipids

NONDEPARTMENTAL COURSES

ALS 100(1000) College and Career Exploration in the College of Agriculture and Life Sciences
Summer. 1 or 3 credits. Prerequisite: high school juniors or seniors. Letter grades only. Staff.
This program is a great opportunity to explore possible majors, careers, and research opportunities in Cornell's world-class College of Agriculture and Life Sciences (CALS) while earning college credit. The one-week program, for 1 credit, will consist of students attending presentations by admissions, career, and student services offices; talk with faculty members, staff, and students; visit labs and research facilities; enjoy field trips; participate in team projects; and write several short papers. You'll also focus on two of CALS's four priority areas. The three-week program, for 3 credits, combines the one-week program with two additional weeks of in-depth, hands-on exploration into the two subject areas you selected during the first week.

ALS 101(1101) Transition to and Success at Cornell
Fall. 1 credit. Prerequisite: entering students in CALS. Letter grades only. Staff and CALS Career Development Office.
Discussion-oriented course to enable all new CALS students to enjoy their experience at and transition to Cornell. Lecture, discussion, guest speakers, student panels, and assignments that explore Cornell's history, academic opportunities, services, and organizations are used. Emphasizes the role of Agriculture and Life Sciences in the future of all related careers.

ALS 134(1340) Emergency Medical Technician
Fall and spring. 3 credits each semester. Two-semester course; students enroll in fall semester only. Recommended: basic or advanced first aid. S-U or letter grades. D. A. Grossman, R. Kniffen, and A. E. Gantert.
Intensive 140-hour course taught throughout the fall and spring semesters. Includes training in C.P.R. for the professional rescuer, oxygen administration, airway management, fracture management, bleeding control, patient assessment, spinal immobilization, the use of medical antishock trousers, and defibrillation. Students qualify for the New York State E.M.T. Certification Exam upon successful completion of the course.

ALS 135(1350) Advanced Emergency Medical Technician, Critical Care
Fall and spring; two-semester course. 4 credits each semester. Prerequisite: current certification as N.Y.S. Basic E.M.T. or have applied for reciprocity. S-U or letter grades. D. Grossman and staff.
Includes topics such as emergency pharmacology, patient assessment, advanced cardiac life support, emergency hypoperfusion management, and basic trauma life support. Uses classroom, lab, hospital, and field sessions to teach skills such as intubation, emergency IV access, electro-cardioversion and defibrillation, and patient assessment and pharmacological intervention. Requires extensive out of classroom (exceeds 140 hours) time.

ALS 392(3920) New York State Government Affairs (also PAM 392[3920])
Spring. 15 credits. Prerequisite: junior or senior standing; minimum GPA of 2.3. W. Rosen.
For description see PAM 392.

ALS 400(4000) Internship
Fall, spring, or summer. 6 credits max. Not open to students who have earned internship credits elsewhere or in previous semesters. S-U grades only.
Students may register only for internships in the New York State Assembly Intern Program, the New York State Senate Session Assistant's Program, and the Albany Semester Program. A learning contract is negotiated between the student and the faculty supervisor(s), stating conditions of the work assignment, supervision, and reporting. Requires participation in any structured learning activities associated with the internship.

ALS 476(4760) Environmental Stewardship in the Cornell Community I
Fall. 1 credit. Prerequisite: freshmen and new students. S-U or letter grades. R. Sherman.
This two-semester course is an opportunity for you to become involved with the Cornell Sustainable Campus initiative by designing and implementing a project that promotes environmental stewardship on campus. During the fall semester, we will explore concepts of sustainability, meet with student leaders of various campus organizations who are promoting Cornell's mission of sustainability, and learn about what has been done and what is being done to achieve a more environmentally friendly campus. In addition, each student will identify a potential project and conduct preliminary work that lays the groundwork for the spring semester course (ALS 477). Note: You are *not* required to take ALS 477 if you take ALS 476, and you can take ALS 477 without taking ALS 476.

ALS 477(4770) Environmental Stewardship in the Cornell Community II
Spring. 2–4 credits, variable. J. M. Regenstein, plus faculty advisor.
Each student undertakes an original project to improve the environment at Cornell while working with a faculty advisor and the Cornell infrastructure (generally campus life and/or facilities). Through class discussions, students learn how to be more effective at developing environmental programs in the future, both during and after college. Students present the final written project report orally at a public forum. (**Note:** If students prefer to take 1 or 2 credits of independent research in a department in the College of Agriculture and Life Sciences, this can be arranged. Assistance in finding a faculty advisor is provided. May be taken more than once.)

ALS 494(4940) Special Topics in Agriculture and Life Sciences
Fall or spring. 4 credits max. S-U or letter grades.
The college teaches "trial" or temporary courses under this number. Offerings vary by semester and are advertised by the college before the beginning of the semester. The same course is not offered more than twice under this number.

ALS 499(4991/4992) Honors Project I and II (also B&SOC/S&TS/HE 499[4991/4992])
Fall and spring (yearlong). 8 credits (register for 8 credits each semester; total credits awarded is 8). Prerequisite: biology & society seniors and permission of department; overall GPA of 3.3. Apply in 306 Rockefeller Hall.
Students who are admitted to the honors program are required to complete two semesters of honors project research and to write an honors thesis. The project must include substantial research and the completed work should be of wider scope and greater originality than is normal for an upper-level course.

ALS 500(4998) Politics and Policy: Theory, Research, and Practice (also AM ST 501[4998], PAM 406[4998], GOVT 500[4998])
Students in CALS must register for ALS 500. S. Jackson and staff.
This course, taught in Washington, D.C., forms the core of the public policy option of the Cornell in Washington program. The central objective is to provide students with the instruction and guidance necessary to analyze and evaluate their own chosen issue in public policy. Toward that end, the course has three components: (1) weekly lectures providing background on the structures and processes of national politics and policy as well as training in research methodology; (2) student externships; and (3) individual research papers or projects. All three components interrelate to provide students with a strategy and framework for integrating classroom-based learning, field experience, and individual research. Students apply through the Cornell in Washington office, M101 McGraw Hall, or online at ciw.cornell.edu.

ALS 580(5800) International Teaching Assistant Development Program Course 3
Fall or spring. 2 credits. Prerequisite: EDUC 579. ITADP staff.
Specifically designed for international graduate students who plan to assume teaching assistant responsibilities that range from lab introductions to individual tutoring sessions. Participants address English-language issues relating to phonemes, grammar, and suprasegmentals. Activities in these areas target communicative functions such as presenting concepts, initiating and sustaining conversation, and interpreting information in academic settings.

ALS 581(5810) International Teaching Assistant Development Program Course 4
Fall or spring. 2 credits. Prerequisite: ALS 580. ITADP staff.
Specifically designed for international graduate students who have completed ALS 580 and who plan to assume teaching assistant responsibilities that range from lab introductions to individual tutoring sessions.

Participants develop skills in self-monitoring, critical listening and language fluency with attention to time frame usage, academic terminology, extended discourse, and compensatory speech strategies.

ALS 661(6610) Environmental Policy (also B&SOC 461[4611], BIOEE 661[6610])
Fall and spring. 3 credits each semester; students must register for 6 credits each semester since "R" grade is given at end of fall semester. Limited to 12 students. Prerequisite: permission of instructor. D. Pimentel.
For description, see BIOEE 661.

APPLIED ECONOMICS AND MANAGEMENT

W. H. Lesser, chair (154 Warren Hall, 255-4576); C. B. Barrett, N. L. Bills, G. Blalock, V. L. Bogan, R. N. Boisvert, N. H. Chau, R. D. Christy, J. M. Conrad, R. T. Curtis, H. Daouk, H. de Gorter, B. A. Gloy, C. Gomes, D. A. Grossman, D. R. Just, H. M. Kaiser, S. M. Kanbur, W. A. Knoblauch, S. C. Kyle, D. R. Lee, A. E. Leiponen, J. E. Little, E. W. McLaughlin, T. D. Mount, D. T.-C. Ng, A. M. Novakovic, P. D. Perez, D. J. Perosio, G. L. Poe, E. Prasad, J. E. Pratt, J. T. Prince, S. P. Raj, C. K. Ranney, T. M. Schmit, W. D. Schulze, D. H. Simon, M. W. Stephenson, D. H. Streeter, L. W. Tauer, W. G. Tomek, C. G. Turvey, C. L. van Es, A. Wang, B. Wansink

Courses by Subject

Agribusiness management: 302, 403, 404, 405, 427, 608, 708

Statistics, quantitative methods, and analytical economics: 210, 410, 411, 412, 415, 417, 419, 711, 712, 713, 714, 717

Management, finance, law, and accounting: 220, 221, 222, 320, 321, 322, 323, 324, 325, 329, 420, 421, 422, 424, 425, 427, 428, 429, 437

Policy and international trade: 230, 335, 430, 431, 432, 433, 434, 630, 632, 633, 634, 730, 735

Marketing and food distribution: 240, 241, 342, 344, 346, 442, 443, 444, 446, 447, 448, 449, 640, 641

Environmental and resource economics: 250, 450, 451, 455, 651, 655, 750

Economics of development: 464, 660, 667, 762, 765

Consumer economics: 670

General, contemporary issues, research, and other: 101, 200, 380, 494, 497, 498, 499, 694, 698, 699, 700, 800, 900, 901

AEM 101(1101) Introduction to Applied Economics and Management
Fall. 1 credit. Prerequisite: required of and limited to freshmen in AEM. S-U grades only. D. A. Grossman and A. M. Novakovic.
The purpose of this course is to acquaint first-year students in AEM with their new department and better enable them to make academic and early career decisions. A cross-section of faculty will lead discussions that introduce most of the major academic subjects taught in AEM. In addition, there are guest presenters on topics such as career planning, student organizations, course planning, and ethics and academic integrity. There are several homework assignments.

AEM 120(1200) Foundations of Entrepreneurship and Business
Fall. 2 credits. P. D. Perez.
Introductory course providing a sound base to both the understanding of entrepreneurial activity and possibilities and the study and practice of entrepreneurship at Cornell. Includes lectures, selected guest appearances by successful entrepreneurs, and extensive use of IT-based learning and presentation tools.

AEM 121(1210) Entrepreneurship Speaker Series
Fall. 1 credit. M. P. D. Perez.
Seminars and guest lectures by faculty members engaged in the study and practice of entrepreneurship and by prominent entrepreneurs associated with the Entrepreneurship and Personal Enterprise program at Cornell, with a view to inform and inspire students. Evaluation includes attendance and written feedback on lectures. Intended as a companion to AEM 120 but may be taken independently.

AEM 122(1220) Entrepreneurship in the Life Sciences
Spring. 1 credit. W. Lesser.
Seminars and guest lectures by faculty members and entrepreneurs engaged in the study and practice of entrepreneurship in the life sciences. Emphasis on the process of turning scientific discovery into business opportunity and success. Evaluation includes attendance and written feedback on lectures. Intended as a followup to AEM 120 and AEM 121 but may be taken independently.

[AEM 200(2000) Contemporary Controversies in the Global Economy
Fall. 3 credits. Prerequisite: ECON 101. Recommended: ECON 102. Priority given to sophomores and juniors in AEM. Next offered 2008–2009. C. Barrett.
Aims to stimulate critical thinking and cogent writing and speaking about contemporary controversies that attract regular attention in the international press and among key private and public sector decision-makers. Students read and discuss competing arguments about current issues such as patenting and pricing of pharmaceuticals worldwide, controls on commercial and humanitarian distribution of genetically modified foods, and immigration restrictions. Students write a series of short briefing papers and give regular oral briefs, which are evaluated for quality of communication and content.]

AEM 210(2100) Introductory Statistics
Spring. 4 credits. Prerequisite: EDUC 115 or equivalent level of algebra. Two evening prelims. C. van Es.
Introduces statistical methods. Topics include the descriptive analysis of data, probability concepts and distributions, estimation and hypothesis testing, regression, and correlation analysis. Includes an introduction to Minitab, a statistical software package.

AEM 220(2200) Introduction to Business Management (D)
Spring, summer. 3 credits. Two evening prelims. P. D. Perez.
Provides an overview of management and business. Human resource, marketing, finance, and strategy concerns are addressed with consideration paid to current issues such as technology and its impact on operations, globalization, ethics, quality, and entrepreneurship. Guest speakers are an important part of the course.

AEM 221(2210) Financial Accounting
Fall, spring, summer. 3 credits. Not open to freshmen. Priority given to CALS majors. Two evening prelims. J. Little.
Comprehensive introduction to financial accounting concepts and techniques, intended to provide a basic understanding of the accounting cycle, elements of financial statements, underlying theory of GAAP, and financial statement interpretation. Topics include methods of recording inventory, receivables, depreciation, bonds, and equity. Requires two evening prelims and a comprehensive final; weekly homework assignments.

AEM 222(2220) Business Management Case Analysis
Spring. 1 credit. Requirement for and limited to AEM majors. P. D. Perez.
Offers students teams the opportunity for hands-on application of general business management concepts through discussion and written analysis of a series of cases. Case topics are closely coordinated with both the content and sequencing of material presented in AEM 220.

AEM 230(2300) International Trade and Finance (also ECON 230[2300])
Fall. 3 credits. Prerequisites: ECON 101 or equivalent. Recommended: ECON 102 or equivalent. S-U or letter grades. One evening prelim. D. R. Lee.
One-semester introduction to international economic principles and issues. Begins by surveying key topics such as the elements of comparative advantage, tariff and nontariff barriers, and multilateral institutions. The second part of the course treats selected topics in international finance, including exchange rates, balance of payments, and capital markets. Discusses current issues such as the effects of trade liberalization, trade and economic growth, and instability in international capital markets. Designed as a less technical introduction to concepts developed at a more advanced level in AEM 430 and ECON 361–362.

AEM 240(2400) Marketing
Fall, summer. 3 credits. E. W. McLaughlin.
Provides a broad introduction to the fundamentals of marketing. Explores the components of an organization's strategic marketing program, including how to price, promote, and distribute goods and services. Industry guest lectures and current marketing applications from various companies are presented and analyzed.

AEM 241(2410) Marketing Plan Development
Fall. 2 credits. Requirement for and limited to AEM majors. D. J. Perosio.
Offers student teams the opportunity for an intense, hands-on application of basic marketing concepts through research and development of a marketing plan. Guided by a series of assignments, teams develop key components that are integrated into a comprehensive written plan for a local business.

AEM 250(2500) Environmental and Resource Economics
Spring. 3 credits. S-U or letter grades. G. Poe.
Introduces fundamental economic principles and the "economic approach" to policy issues, and demonstrates how these concepts underpin contemporary environmental and natural resource issues and policy solutions. Subjects include valuation, benefit-cost analysis, policy design, property rights, and ecological economics. Uses these tools to explore major current policy issues such as economic incentives in environmental policy, endangered species protection, air and water pollution, depletion of renewable and nonrenewable resources, and global warming.

AEM 302(3020) Farm Business Management
Fall. 4 credits. Not open to freshmen. Prerequisite for AEM 405 and 427. W. A. Knoblauch.
Intensive study of planning, directing, organizing, and controlling a farm business, with emphasis on the tools of managerial analysis and decision making. Topics include financial statements, business analysis, budgeting, and acquisition, organization, and management of capital, labor, land, buildings, and machinery.

AEM 320(3200) Business Law I (also NBA 560[5600])
Fall and summer. 3 credits. Prerequisite: junior, senior, or graduate standing. One evening prelim. D. A. Grossman.
Examines legal problems of particular interest to persons who expect to engage in business. Emphasizes the law of contracts, sales, agency, and property.

AEM 321(3210) Business Law II (also NBA 561[5610]) (D)
Spring. 3 credits. Prerequisite: junior, senior, or graduate standing; business law course or permission of instructor. D. A. Grossman.
The first portion of this course examines legal issues in the formation and operation of business enterprises, particularly partnerships, corporations, and limited liability companies. The second portion reviews selected topics in business law, like employment discrimination, debtor/creditor relations, product liability, unfair competition, e-commerce law, and international business law.

AEM 322(3220) Internet Strategy
Spring. 3 credits. Prerequisites: AEM 220 and ECON 101. A. Leiponen.
Explores the impact of new technologies on business processes and industries. Focuses particularly on the effects of information and communication technologies (ICT). The objective is to understand the nature of information as an economic good, business opportunities and challenges created by ICT, and organizational constraints involved in exploiting these opportunities.

AEM 323(3230) Managerial Accounting
Spring. 3 credits. Priority given to CALS majors. Prerequisite: AEM 221 or equivalent. Two evening prelims. J. Little.
Introduction to cost accounting emphasizing the application of accounting concepts to managerial control and decision making. Major topics include product costing, standard costing, cost behavior, cost allocation, budgeting, variance analysis, and accounting systems in the manufacturing environment. Requires use of electronic spreadsheets. Includes two evening prelims, a third exam, weekly homework.

AEM 324(3240) Finance
Fall. 4 credits. Priority given to CALS majors. Prerequisites: AEM 210, 220, and 221, or equivalents. Three evening prelims. R. Curtis.
Focuses on the mathematics of finance, valuation, and the economics of managerial decisions, corporate financial policy, risk management, and investments. Topics include the time value of money, bond and stock valuation, capital-budgeting decisions, financing alternatives, the cost of capital and the capital-structure decision, distribution policy, mergers and acquisitions and restructuring, options, forward and futures contracts, market efficiency and market anomalies, strategies of successful investors, and personal finance.

AEM 325(3250) Personal Enterprise and Small Business Management
Spring. 4 credits. Prerequisites: junior or senior standing; AEM 220 and 221 or permission of instructor. Absolutely no adds or drops after second class meeting. Cost of term project: approx. $100 per team. D. Streeter.
Focuses on the activities involved in planning a start-up business, including the exploration of strategic dimensions, performance of marketing research, and planning of financial aspects related to the new company. Lectures and hands-on clinics include visits by real world entrepreneurs, who discuss the start-up process and the challenges of managing growth in a small business. Term project is the development of a business plan, completed in teams of no fewer than three students.

AEM 328(3280) Innovation and Dynamic Management (also H ADM 443[4443])
Spring. 3 credits. Prerequisite: junior or senior standing. Staff.
For description, see H ADM 443.

AEM 329(3290) International Agribusiness Study Trip
Fall. 2 credits. Prerequisites: AEM 220 or 302, and 240. Open by application before March 1 of spring semester before course is offered. Approximately 12 students are selected with preference given to sophomores and juniors in CALS. Field study co-payment: $800. L. W. Tauer and T. Schmit.
Gives students interested in agribusiness management exposure to the managerial practices essential to the success of agriculture, agribusiness, and food companies competing in the global marketplace. Involves a two-week international field study trip that takes place after the final exam period of the spring semester before the course is offered. The course meets for a few sessions in advance of the field study trip. A paper analyzing an aspect of the field study is required.

AEM 330(3300) Managerial Economics and Decision Making
Spring. 3 credits. Prerequisite: ECON 101. D. Simon.
Focuses on tools for making various decisions managers encounter in the real world, including decisions of pricing, output, advertising expenditures, and new product introductions. Considers issues such as how to estimate a firm's demand and cost functions as considered in making such decisions. Compares standard microeconomic models with more realistic approaches to making decisions. Emphasizes considering decisions that are less stylized and more similar to those managers face on a regular basis.

AEM 331(3310) Economics of Business Regulation
Spring. 3 credits. Prerequisites: ECON 101, 313, and AEM 220. S-U or letter grades. J. Prince.
Studies the economics and other factors (e.g., politics, lobbying) that determine regulation policy along with firm strategies in regulated or potentially regulated markets. Major topics include: antitrust, economic regulation and environmental regulation. Applications to the current business environment are emphasized.

AEM 333(3330) European Business Institutions
Spring. 1 credit. Prerequisites: ECON 101 and AEM 220. A. Leiponen.
This course examines the institutional environment of business in Europe on different levels including national and supranational (EU) power structures, forms of business organization and governance, and culture and values. As a result of this course, students will be able to understand and be sensitive to the drivers of business behavior and performance in a foreign, particularly European, context.

AEM 334(3340) Women, Leadership, and Entrepreneurship (D)
Fall. 1 credit. Prerequisite: junior or senior standing. D. Streeter.
Seminar that uses lectures, guest panels, and readings to focus on issues facing women (and their partners) in their business careers. Topics include status of women in business leadership, pathways and strategies for leadership development, family/life balance issues, gender issues in the workplace, and resources for emerging leaders.

AEM 335(3350) International Technology Marketing of Biotechnology
Spring. 3 credits. Prerequisites: ECON 101 and BIO G 109 or equivalents. S-U or letter grades. W. H. Lesser.
Explores international technology marketing from an economics perspective using biotechnology as an example. Topics include technology theories, products, risk (health and environmental) regulation, industry structure, labeling uses and regulations, public perceptions, patents, trade, and international conventions. The course is of interest to students of biotechnology, public technology policy, and international technology marketing.

AEM 336(3360) Intermediate Accounting I
Fall. 3 credits. Prerequisites: AEM 221 and 323. Staff.
Includes an overview of Generally Accepted Accounting Principles, balance sheet valuation and income measurement and recognition. Other topics include accounting for pensions, earnings per share and special financial reporting issues.

AEM 342(3420) Integrated Marketing Communication
Fall. 3 credits. Prerequisite: introductory marketing course; junior or senior standing. Staff.
Focuses on decisions regarding communication and promotion decisions in companies that market consumer products and services. Course also explores how business-to-business communication differs. Responsibility for many of these decisions typically resides under the brand-management umbrella and calls for an integrated approach to planning, budgeting, and evaluating advertising, sales promotion, and public relations.

AEM 344(3440) Consumer Behavior
Fall. 3 credits. Prerequisites: AEM 240 or equivalent. B. Wansink.
Develops a useful, conceptual understanding of the problems and strategies associated with psychology behind consumer behavior. In doing so, the course provides frameworks that enable students to address these issues responsibly, systematically, and creatively.

AEM 346(3460) Dairy Markets and Policy
Spring. 3 credits. Prerequisites: junior, senior, or graduate standing; ECON 101 or equivalent. S-U or letter grades. A. Novakovic.
Survey of topics related to the structure and performance of U.S. dairy markets and federal and state policies that regulate market activities. Emphasizes learning both the origin and characteristics of dairy policies and methods for analyzing their impacts on market performance.

AEM 380(3800) Independent Honors Research in Social Science
Fall or spring. 1–6 credits. Prerequisite: requirements for honors program met (see "Honors Program" under CALS).
Provides qualified students an opportunity to conduct original research under supervision. Information is available in the AEM undergraduate program office in Warren Hall.

AEM 403(4030) Farm Management Study Trip
Spring. 1 credit. Prerequisite: AEM 302. Open by application only. W. A. Knoblauch and B. Gloy.
Special program to study production and management systems in diverse agricultural regions of the United States. Includes a trip (usually taken during spring break) to the region being studied. A different region is visited each year. The course meets in advance of the study trip and upon return from trip. Students must write a paper that further explores an aspect of the trip.

AEM 404(4040) Advanced Agricultural Finance Seminar
Spring. 3 credits. Limited to 16 students. Prerequisite: senior standing; extensive course work in farm management and farm finance. Open by application before March 1 of year before course is offered. C. Turvey.
Special program in agricultural finance, conducted with financial support from the Farm Credit System. Includes two days at Northeast Farm Credit offices, one week in Farm Credit Association offices, a one-day program on FSA financing during fall semester, a two- to four-day trip to financial institutions in New York City, and an actual farm consulting and credit analysis experience in the spring semester.

AEM 405(4050) Agricultural Finance
Spring. 4 credits. Prerequisite: AEM 302 or equivalent. Recommended: calculus and statistics. C. Turvey.
Discusses the principles and practices used in financing agricultural businesses, from the perspectives of the business owner and the lender. Topics include sources of capital, financing entry into agriculture, financial analysis of a business, capital management, financial statements, credit instruments, loan analysis, financial risk, and leasing.

AEM 410(4100) Business Statistics
Fall. 3 credits. Prerequisite: AEM 210 or equivalent. C. van Es.
Focuses on techniques used to analyze data from marketing research, business, and economics. Topics include experimental design and ANOVA, contingency-table analysis, quality-control methods, time-series analysis and forecasting. Also includes brief introductions to nonparametric methods and multivariate analysis. Involves a research project designed to give experience in collecting and interpreting data.

AEM 411(4110) Introduction to Econometrics
Fall. 3 credits. Prerequisite: AEM 210 and either ECON 313 or PAM 200 or equivalents. D. Just.
Introduces students to basic econometric principles and the use of statistical procedures in empirical studies of economic models. Introduces assumptions, properties, and problems encountered in the use of multiple regression are discussed and simultaneous equation models, simulation, and forecasting techniques.

AEM 412(4120) Computational Methods for Management and Economics
Spring. 3 credits. Primarily for juniors, seniors, and M.S. degree candidates. Prerequisite: AEM 210 or equivalent. C. Gomes.
Course in applied mathematical programming. Emphasizes formulation of and interpretation of solutions to mathematical models of problems in economics and business. Studies blending, resource allocation, capital budgeting, transportation and financial planning, and inventory management. Introduces integer and nonlinear programming.

AEM 413(4130) Business Strategy Research
Fall. 3 credits. Prerequisite: AEM 210 or equivalent statistics course. G. Blalock.
AEM 413 introduces empirical microeconomic research methods applied primarily to questions of business strategy. The course objective is to familiarize students with the potential problems of business strategy research and the methods employed to overcome those problems. Students will read and discuss peer-reviewed academic journal articles in business and economics.

AEM 414(4140) Behavioral Economics and Managerial Decisions
Fall. 3 credits. Prerequisites: junior or senior standing; ECON 313 or PAM 200. Lab fee: $40. D. Just.
Behavioral economics integrates psychology and economics by identifying systematic anomalies in decision-making. These are now recognized to be an important source of error in business decisions, and provide the foundation for both behavioral marketing and finance. The course compares rational choice theory with behavior both in lecture and through a series of economics experiments in which students face situations that are likely to lead to anomalies such as "the winner's curse," the status quo bias, hyperbolic discounting, and bias in assessing risks. Students have the opportunity to evaluate their own decision-making.

AEM 415(4150) Price Analysis
Fall. 3 credits. Prerequisites: AEM 210 or equivalent, ECON 313 or PAM 200 or equivalent. H. M. Kaiser.
Focuses on the analysis of supply and demand characteristics of commodities with particular attention to agricultural products. Pays special attention to empirical analysis. Includes institutional aspects of pricing, temporal and spatial price relationships, price forecasting, and the economic consequences of pricing decisions.

AEM 417(4170) Decision Models for Small and Large Businesses
Fall. 3 credits. Prerequisites: junior or senior standing (priority given to AEM majors); AEM 210 or equivalent. No F lec in weeks labs are held. C. L. van Es.
Focuses on economic and statistical models of decision analysis and their applications in large and small business settings. Demonstrates how use of models can improve the decision-making process by helping the decision maker. Emphasizes the importance of sensitivity analysis and the need to combine both quantitative and qualitative considerations in decision making. Draws cases from small business scenarios, the public policy arena, and corporate settings. Lab sessions focus on implementing decision models with computers.

[AEM 419(4190) Strategic Thinking
Spring. 3 credits. Prerequisite: PAM 200 or ECON 313. S-U or letter grades. Next offered 2008–2009. N. H. Chau.
The art of thinking strategically puts outdoing one's adversary at the core of the decision-making process, while anticipating that the adversary is doing exactly the same thing. Businesses make investment decisions and innovate products in anticipation of the reaction of their rivals; managers make pay contingent on peer performance, taking into account the reaction of their subordinates and superiors; national trade policies are formulated based on whether trading partners are committed to make credible concessions. This course introduces and explores the use of game theory to understand these interactions; students are expected to work with a balanced dose of both theory and relevant case studies. The objective of the course is to facilitate students' ability to think strategically on firm level issues (e.g., pricing, advertising wars, product differentiation, and entry deterrence) and strategic policy interaction in international economic relations (e.g., trade wars, and the arms race).]

AEM 420(4200) Investments
Spring. 3 credits. Prerequisites: AEM 210 or equivalent and AEM 324. Recommended: basic knowledge of statistics and linear algebra. Priority given to AEM students. Letter grades only. A. Wang.

Introduces the basic conceptual frameworks and analytical tools used in investment analysis. These tools are then applied to a variety of financial applications, both theoretical and empirical. Topics include: forwards and futures, portfolio theory, CAPM, options, financial management, and selected advanced topics. A portion of this course involves the use of a spreadsheet or other computer programs.

AEM 421(4210) Derivatives and Risk Management
Fall. 3 credits. Prerequisites: AEM 210 and 324 or equivalents. Recommended: ECON 313 or equivalent and a calculus course; familiarity with calculus and probability and statistics. Priority given to AEM students. S-U or letter grades. H. Daouk.
Covers the pricing of derivatives and how derivatives can be used for the purpose of risk management and speculation. A portion of this course involves the use of a spreadsheet or other computer programs.

AEM 422(4220) Estate Planning (also NBA 562[5620])
Fall. 1 credit. Prerequisite: junior, senior, or graduate standing. S-U grades only. D. A. Grossman.
Fourteen sessions on the various aspects of estate planning techniques. Covers the law and use of trusts, the law of wills, federal and New York State estate and gift taxes, and substitutes for probate procedures.

AEM 423(4230) Contemporary Topics in Applied Finance
Fall. 3 credits. Prerequisites: ECON 101, MATH 111 or equivalent, AEM 210 or equivalent, AEM 324. Letter grades. V. Bogan.
Stimulates critical thinking about contemporary topics that attract attention in the press and among key finance decision-makers. This analytical course draws on the theory of modern finance to facilitate the understanding of real world issues. Covers traditional topics in financial markets such as security trading, derivatives, fixed income, IPOs, portfolio formation, and market efficiency. Also explores newer issues such as technology and financial markets.

AEM 424(4240) Management Strategy
Fall and spring. 3 credits. Prerequisite: AEM seniors in business. Fall, G. Blalock; spring, D. Simon.
Capstone course designed to integrate what students have learned in other AEM courses with an emphasis on strategic decision making. Approaches issues from the standpoint of the board of directors, chief executive officer, and business unit managers. Focuses on what should be considered and how strategic decisions should be made.

AEM 425(4250) Small Business Management Workshop
Fall. 4 credits. Prerequisite: senior standing, AEM 325 or NBA 300 and permission of instructor. Cost of term project: approx. $100 per team. D. Streeter.
Students serve as counselors to small businesses in the central New York area and confront problems facing small personal enterprises. Encourages the application of business principles to an existing business and the witnessing of the results of firm-level decision making. Student teams meet with the business owners and course staff members at arranged times during the semester.

AEM 426(4260) Fixed-Income Securities
Fall. 3 credits. Prerequisites: MATH 111 or equivalent, AEM 210 or equivalent, AEM 324. Letter grades. V. Bogan.
This course focuses on fixed-income securities including corporate bonds, default-free bonds, and floating rate notes. Other topics include related financial instruments such as forwards and futures on fixed-income securities, interest rate swaps, bond options, and mortgage-backed securities. In addition to the analysis of specific types of fixed-income securities, there will be an examination of the tools used in bond portfolio management.

AEM 427(4270) Agribusiness Strategy
Fall. 3 credits. Prerequisite: AEM 220 or 302. Staff.
Intended for students with an interest in agribusiness and designed to integrate previous course work and enhance problem identification and solving skills. Focuses on the evaluation, formulation, and implementation of strategy designed to create and sustain competitive advantage for agribusiness firms. Covers industry analysis, firm analysis, market analysis and selection, risk analysis, strategy development, organizational design and structure, and leadership for agribusiness firms. Designed as a capstone course for the agribusiness management specialization.

AEM 428(4280) Valuation of Capital Investment
Spring. 3 credits. Prerequisites: AEM 210 and 324 or equivalents. D. T.-C. Ng.
Focuses on the analysis of financial information—particularly firms' financial reports—for making decisions to invest in businesses. The primary focus is on equity (share) valuation, with some attention given to credit analysis. Examines various valuation models in detail and applies them in cases and projects involving listed companies. Topics include models of shareholder value, discounted cash flow approaches to valuation, the analysis of profitability, growth, and valuation generation in a firm, forecasting earnings and cash flows, proforma analysis for strategy and planning, analysis of risk, and the determination of price/earnings and market-to-book ratios.

AEM 429(4290) International Finance
Spring. 3 credits. Prerequisites: AEM 210 and 324. S-U or letter grades. D. T.-C. Ng.
Teaches students about issues in international financial management and international investment. The major issues discussed include exchange rate volatility, the benefit of international diversification, and the analysis of international capital budgeting decisions. Specific topics include the determination of the cost of capital for foreign investments, the determination and management of foreign exchange risks and country risks, and the use of innovative financing for the multinational corporation.

AEM 430(4300) International Trade Policy
Spring. 3 credits. Prerequisites: ECON 101–102 or equivalents and intermediate microeconomics course. S-U or letter grades. N. H. Chau.
Examines the economic principles underlying international trade and monetary policy, and the policies, practices, and institutions that influence trade and foreign exchange markets. Also emphasizes applications to current topics in international trade policy, to trade in primary commodities, and to both developed and developing countries.

AEM 431(4310) Agricultural and Food Policy
Spring. 3 credits. Prerequisites: junior, senior, or graduate standing; PAM 200, ECON 301, 313, or equivalent. S-U or letter grades. A. Novakovic.
Acquaints students with current and historically important U.S. policies related to agriculture and food, including subsidies and regulations related to markets, production, and the environment. Explores methods of policy analysis, and students learn to critique policies and write policy briefs.

AEM 432(4320) Public Private Sector Economics Linkages
Spring. 3 credits. Prerequisite: intermediate microeconomics course. C. K. Ranney.
The government agency and the individual business enterprise are two of the most powerful institutions in modern society. This course looks at the economic interfaces between government and business. The shifting and complicated relationships between them exert great influence on the changing performance of the economy and on the lives of citizens. These relationships range from cooperative to competitive, from friendly to hostile. It is an uneasy relationship, each side possessing basic powers and yet each having an important need for the other. In the United States, the result is a mixed economy in which the public and the private sectors interact in many ways. Government exercises a variety of important powers in dealing with the individual private enterprise, ranging from taxation to regulation. Business, in turn, relies on constitutional protections as well as on public support of its basic role in creating income, employment, and material standards of living. In a dynamic and increasingly globalized economy, the business-government relationship is constantly changing and the line between public and private sectors frequently shifts. Future managers are constantly confronted with issues that relate to government-business interfaces.

AEM 434(4340) Government Policy Workshop (also CRP 418[4180], FGSS 420[4200])
Spring. 4 credits. S-U or letter grades. M. E. Warner.
For description, see CRP 418.

AEM 435(4350) Political Economy of the WTO
Spring. 3 credits. Prerequisite: intro microeconomics. H. deGorter.
The politics of the WTO and trade policy are explored. We examine what the WTO is, how it operates, how much power it really has, why it was created, incentives for governments to cooperate. How WTO rules affect domestic politics and foreign policy goals and how WTO rules and agreements are enforced. We also debate the effect of trade on growth and poverty.

AEM 437(4370) Innovation Strategy
Spring. 3 credits. Prerequisites: AEM 220 and ECON 101. A. Leiponen.
Explores innovation and technological change. Studies how technological change

affects economies and industries, and how innovation of new products, processes, and services takes place in firms. Group projects involve case studies of local high-tech startup companies.

AEM 442(4420) Emerging Markets
Fall. 3 credits. Prerequisites: senior or graduate standing; AEM 240 and PAM 200 or ECON 313. R. D. Christy.
Provides a framework for examining the effectiveness of marketing strategies in economies in transition and identifying the challenges and opportunities for firms in low-income economies to access industrial markets. Appraises the risk of entering markets in low-income economies and assesses the political, legal, cultural, and economic forces. Analyzes and discusses case studies of companies.

[AEM 443(4430) Food-Industry Strategy
Fall. 3 credits. Prerequisite: AEM juniors, seniors, or graduate students; AEM 240 or 448; or permission of instructor. Next offered 2008–2009. Staff.
Examines the decisions that businesses must make, such as what to sell, where to invest, when to outsource, and how to market—all in a changing and competitive environment. While the principles are applicable to any competitive environment, the focus is on one industry, the food industry, to allow an in-depth look at how the various players (manufacturers, retailers, and others) both cooperate and compete in the process of supplying food to consumers. Students learn how such issues as globalization, industry consolidation, new technologies, and health concerns add to their challenges and opportunities.]

AEM 444(4440) Marketing Strategy and Brand Management
Fall. 3 credits. Prerequisite: AEM 240; junior or senior standing. Staff.
A sound marketing strategy is essential for the long-term success of a firm. This requires an understanding of how customer needs evolve, how product-market boundaries shift, and how competitors are likely to react. The strategic roles of existing and new products need to be assessed, appropriate resource allocations made, and strategies developed to ensure sustained growth. The course is designed to provide opportunities to learn about the theoretical and applied perspectives of marketing strategy from readings, case analyses, and guest speakers.

AEM 445(4450) Food Policy for Developing Countries (also NS 445[4450])
Fall. 3 credits. Prerequisites: 6 credits in economics, applied economics, or sociology and 6 credits in nutrition and/or agricultural sciences. P. Pinstrup-Andersen.
Comprehensive presentation and discussion of policy options for a sustainable global food system, with focus on developing countries. Topics include economic policy related to nutrition, health, consumption, production, natural resource management, trade, markets, gender roles, armed conflict, and ethics. A social entrepreneurship approach based on case studies and active participation by students will be used.

AEM 446(4460) Food Marketing Colloquium
Fall. 1 credit. Prerequisite: junior or senior standing; extensive course work in food industry management and marketing. D. J. Perosio.
The seminar covers advanced topics in food marketing, many of which have an important international dimension and are presented by industry members. A field trip may be taken. Students participate in research topics on various aspects of the food industry.

AEM 447(4470) Food Marketing Colloquium
Spring. 1 credit. Open to Food Marketing Fellows only. D. J. Perosio.

AEM 448(4480) Food Merchandising
Spring. 3 credits. Prerequisite: junior or senior standing; AEM 240. D. J. Perosio.
Covers merchandising principles and practices as they apply to food industry situations. Examines the various elements of merchandising such as buying, pricing, advertising, promotion, display, store layout, profit planning and control, and merchandising strategy. Considers the consequences of food industry trends and initiatives for other industry members, public policymakers, and consumers.

AEM 449(4490) Global Marketing Strategy (D)
Spring. 3 credits. Prerequisite: junior, senior, or graduate standing; marketing course. Staff.
Examines opportunities and challenges in the rapidly changing global marketplace. Topics include the decision to serve a foreign market, alternative strategies for entry into foreign markets (such as exporting or establishing a local subsidiary), and issues in implementing those strategies. Includes case analysis and discussion.

AEM 450(4500) Resource Economics (also ECON 450[4500])
Fall. 3 credits. Prerequisites: MATH 111, ECON 313, and familiarity with Excel. J. M. Conrad.
Constructs dynamic models of renewable, nonrenewable, and environmental resources to examine market allocation and optimal resource management.

AEM 451(4510) Environmental Economics (also ECON 409[4090])
Spring. 3 credits. Prerequisites: undergraduate standing; intermediate microeconomics course, and calculus. S-U or letter grades. G. L. Poe.
Explores the economic foundations for public decision making about environmental commodities and natural resources, using tools from intermediate microeconomics. Emphasizes the welfare economic approach for allocating public goods, with specific emphasis on market failure, externalities, benefit-cost analysis, nonmarket valuation techniques, and cost-effective policy instruments. Also examines property rights/institutional perspectives and ecological economic concepts.

[AEM 455(4550) Sustainability, Business and the Environment
Fall. 3 credits. Prerequisites: ECON 101 and 102 or equivalent and calculus course. Next offered 2008–2009. Staff.
Seminar giving an inside perspective on implementation and evaluation of environmental policy in a business or organization. Examines the effectiveness of the new market-based green policies; analyze the operational significance of sustainability in a business context; and come to understand the economic basis for government's role in environmental protection. Uses HBS case studies; each seminar participant prepares a case study of environmental management in a business or organization. Makes extensive use of guest speakers from finance, electricity, forest products, construction and manufacturing.]

AEM 460(4600) Security Trading and Market Making
Spring. 3 credits. Prerequisite: AEM 324. Letter grades only. A. Wang.
Theory and practice of securities trading at exchanges around the world. How trading and the design of markets affects liquidity, informativeness, transparency, volatility, and fairness. Analyzes alternative trading strategies and the cost of trading. Examines innovations in security exchanges and regulatory policy. Provides hands-on trading experience using realistic trading simulations.

AEM 464(4640) Economics of Agricultural Development (also ECON 464[4640])
Fall. 3 credits. Prerequisite: ECON 101–102 or permission of instructor. R. D. Christy.
Provides an understanding of the economics of the agricultural sector in low-income countries. Also covers more general issues of economic development beyond the agricultural sector to provide the necessary context for an understanding of rural problems. Topics include the nature of development and technical change, welfare and income distribution, land reform, food and nutrition policy, food security and food aid, competition with more developed countries and international markets, the effect of U.S. policy on agricultural development, and the role of international institutions. Uses examples from a wide variety of developing countries to illustrate the basis for economic analysis.

AEM 494(4940) Undergraduate Special Topics in Applied Economics and Management
Fall or spring. 4 credits max. S-U or letter grades. Staff.
The department teaches "trial" courses under this number. Offerings vary by semester and are advertised by the department before the beginning of the semester.

AEM 497(4970) Individual Study in Applied Economics and Management
Fall or spring. Variable credit. S-U or letter grades. Students must register using independent study form (available in undergraduate program office in Warren Hall). Staff.
Used for special projects designed by faculty members.

AEM 498(4980) Supervised Teaching Experience
Fall or spring. 1–4 credits. Students must register using independent study form (available in undergraduate program office in Warren Hall). Staff.
Designed to give qualified undergraduates experience through actual involvement in planning and teaching courses under the supervision of department faculty. Students cannot receive both pay and credit for the same hours of preparation and teaching.

AEM 499(4990) Undergraduate Research
Fall, spring, or summer. 1–4 credits. Prerequisite: GPA of at least 2.7. Students must register using independent study form (available in undergraduate program office in Warren Hall). S-U or letter grades. Staff.
Permits outstanding undergraduates to carry out independent study of suitable problems under appropriate supervision. Students cannot receive both pay and credit for the same hours of work.

AEM 605(6050) Agricultural Finance
Fall. 3 credits. Prerequisite: AEM 324 or 405 or equivalent B. A. Gloy.
Covers advanced topics in agricultural finance, including investment analysis, capital budgeting under uncertainty, decision analysis, risk management, capital structure, and financial intermediaries.

AEM 608(6080) Production Economics (also ECON 408[4080])
Fall. 3 credits. Prerequisite: ECON 313 and MATH 111 or equivalents. L. W. Tauer.
Studies the theory of production economics with emphasis on applications to agriculture and natural resources. Topics include the derivation, estimation, and use of production, cost, profit, revenue, demand, and supply functions. Discusses the concepts of efficiency and productivity. Introduces production response over time and under risk.

[AEM 611(6110) Global Modeling
Spring. 3 credits. Prerequisite: graduate micro theory course. T. D. Mount and R. N. Boisvert. Taught over Internet by Tom Hertel at Purdue University.
Teaches how to use a global general equilibrium model (GTAP) for research on trade and environment policies. Weekly assignments start with the components of a single-country model and end with a full global model. A final project and the assignments are the primary course requirements.]

AEM 612(6120) Applied Econometrics
Fall. 1 credit. Corequisite: AEM 411. D. Just.
Designed for M.S. and Ph.D. students who do not meet the prerequisites for other graduate-level econometrics courses. Complements AEM 411, providing greater depth of understanding of econometric methods and exposure to applied econometric literature. Focuses on preparing students to conduct their own applied economic research.

AEM 630(6300) Policy Analysis: Welfare Theory, Agriculture, and Trade (also ECON 430[4300])
Spring. 4 credits. Prerequisites: AEM 608 or PAM 603, ECON 313, or equivalent intermediate micro theory course incorporating calculus. H. de Gorter.
The first half of the course surveys the theory of welfare economics as a foundation for public policy analysis. Major issues addressed include the problem of social welfare measurement, the choice of welfare criteria, and the choice of market or nonmarket allocation. Basic concepts covered include measurement of welfare change, including the compensation principle, consumer and producer surplus, willingness-to-pay measures, externalities, and the general theory of second-best optima. The second half focuses on public policy analysis as applied to domestic agricultural policy and international trade. The domestic policy component examines major U.S. farm commodity programs and related food and macroeconomic policies and analyzes their effects on producers, consumers, and other groups. The international trade component examines the structure of world agricultural trade, analytical concepts of trade policy analysis, and the principal trade policies employed by countries in international markets.

AEM 632(6320) Open Economy Analysis: Theory and Applications
Spring. 3 credits. Prerequisites: ECON 313/314 or permission of instructor. S-U or letter grades. N. Chau and S. Kyle.
Explores both recent theoretical and methodological advances as well as practical applications in analyzing current topics and issues in open economies. Brings together research methods pertinent to open economy macroeconomics and international trade policies to give students a basic understanding of how different aspects of contemporary debates are analyzed in practice.

AEM 634(6340) Government Policy Workshop (also CRP 618[6180], FGSS 620[6200])
Spring. 4 credits. S-U or letter grades. M. E. Warner.
For description, see CRP 618.

AEM 640(6400) Analysis of Agricultural Markets (also ECON 440[4400])
Fall. 3 credits. Prerequisites: AEM 411 and 415 or equivalents. Offered even-numbered years. H. M. Kaiser.
Focuses on the unique features of agricultural commodity markets. Emphasizes government and private institutions that affect these markets, as well as on models of price behavior including marketing margins and imperfect competition. Also covers empirical tools to evaluate market characteristics.

AEM 641(6410) Commodity Futures Markets
Spring, weeks 8–14. 2 credits. Prerequisites: AEM 411 and 415 or equivalents. Recommended: AEM 640. W. G. Tomek.
Focuses on markets for agricultural futures contracts. Emphasizes models of price behavior on futures markets including relationships among cash and futures prices. These principles provide a foundation for a discussion of hedging, speculation, and public policy issues.

AEM 642(6420) Globalization, Food Safety, and Nutrition (also NS 642[6420])
Fall. 2 credits. Prerequisites: permission of instructor, graduate standing, and basic understanding of economics and nutrition. Letter grades only. P. Pinstrup-Andersen.
Directed readings course with a weekly 50-minute discussion session. The course is aimed at graduate students in nutrition, agricultural economics, and other relevant fields, who wish to explore how globalization may affect poverty, food security, and nutrition in developing countries and how national policies and international agreements and institutions may influence the outcome. The discussion sessions are based on assigned readings for each week.

AEM 651(6510) Environmental and Resource Economics
Spring. 4 credits. Core course for environmental management concentration/option. Prerequisite: graduate standing. Open to graduate students outside economics. W. D. Schulze.
Review of welfare economics, environmental externalities, and common property resources, and a survey of current environmental and natural resource policy. Covers techniques for measuring benefits and costs—including property value and wage hedonic approaches, travel cost models, and contingent evaluation. Describes survey/data collection methods in detail. Explores innovative market mechanisms for resolving public good, common property, and externality problems. Students are required to complete a paper describing their own formal economic analysis of a natural resource or environmental problem.

AEM 655(6550) Electric Systems Engineering and Economics (also ECE 551[5510])
Fall. 2 credits. Prerequisites: basic calculus and microeconomics courses. T. D. Mount and R. Thomas.
For description, see ECE 551.

AEM 660(6600) Agroecosystems, Economic Development, and the Environment
Spring. 3–4 credits. Prerequisite: graduate standing. Open to graduate students outside economics; additional sec TBA for economics majors. S-U or letter grades. D. R. Lee.
Examines selected topics in agricultural and economic development, technology assessment, ecosystem management and the environment, with a focus on developing countries. Topics include production, poverty, and environmental tradeoffs; sustainable technology development; trade and environment linkages; economics of conservation and development; and alternative methodologies for analyzing these interactions. Readings emphasize the economic literature, but also draw from the biophysical sciences, ecosystem management, and the broader social sciences.

AEM 667(6670) Topics in Economic Development (also ECON 770[7770])
Spring. 3 credits. Targeted to second- and third-year graduate students. Prerequisite: basic first-year courses in ECON or AEM or permission of instructor. S-U or letter grades. R. Kanbur.
Topics vary from year to year but may include poverty, inequality, intra-household allocation, structural adjustment, and debt. Examination is by term paper.

AEM 670(6700) Economics of Consumer Demand (also PAM 608[6080])
Fall. 3 credits. Prerequisites: ECON 311 or 313 and two semesters of calculus. S-U or letter grades. C. K. Ranney.
Graduate-level introduction to theory and empirical research on household demand, consumption, and saving. Emphasizes the use of the theory in empirical research. Topics include neoclassical theory of demand, duality, complete demand systems, conditional demand, demographic scaling and translating, consumption, and savings. As time allows, Becker and Lancaster models of demand may be introduced.

AEM 694(6940) Graduate Special Topics in Applied Economics and Management
Fall or spring. 4 credits max. S-U or letter grades. Staff.
The department teaches "trial" courses under this number. Offerings vary by semester, and are advertised by the department before the beginning of the semester.

AEM 698(6980) Supervised Graduate Teaching Experience
Fall or spring. 1–4 credits; max. 4 credits during graduate program. Prerequisite: graduate standing; permission of instructor. Undergraduates should enroll in AEM 498. Students must register using independent study form (available in undergraduate program office in Warren Hall). S-U or letter grades. Staff.
Designed to give graduate students teaching experience through involvement in planning and teaching courses under the supervision of departmental faculty members. The experience may include leading discussion sections, preparing, assisting in, or teaching lectures and laboratories, and tutoring. Students are expected to actually teach at least one hour per week for each credit awarded. Students may not receive both pay and credit for the same hours of preparation and teaching.

AEM 699(6990) M.P.S. Research
1–6 credits. Prerequisite: M.P.S. students. Credit granted for M.P.S. project report. Staff.

AEM 700(7000) Individual Study in Applied Economics and Management
Fall or spring. Prerequisite: graduate standing. S-U or letter grades. Credit, class hours, and other details TBA with faculty member. Staff.
Used for special projects designed by faculty members. More than one topic may be given each semester in different sections. Student must register in section appropriate to topic being covered; section number is provided by instructor.

[AEM 708(7080) Advanced Production Economics
Fall. 3 credits. Prerequisite: AEM 608, 710, or equivalents. Highly recommended: ECON 609. Offered alternate years; next offered 2008–2009. R. N. Boisvert.
Covers theoretical and mathematical developments in production economics, with emphasis on estimating production relationships, scale economies, technical change, and factor substitution. Emphasizes developments in flexible functional forms, duality, and dynamic adjustment models. Gives considerable emphasis to empirical specification and estimation. Discusses other topics (risk, supply response, and household production functions) based on student interest.]

AEM 710(7100) Econometrics I
Spring. 3 credits. Prerequisites: matrix algebra and statistical methods courses at level of ILRST 311 or ECON 619. H. Daouk.
Provides (together with AEM 711) a graduate sequence in applied econometrics that is suitable for M.S. and Ph.D. students. Covers linear-regression models and the associated estimation and testing procedures.

AEM 711(7110) Econometrics II
Fall. 3 credits. Prerequisite: AEM 710 or equivalent. T. D. Mount.
Coverage beyond AEM 710 of dynamic models, including single equation ARIMA, vector ARIMA, Kalman filtering, structural dynamic models, and regime switching. Topics include endogeneity, stability, causality, and cointegration.

AEM 712(7120) Quantitative Methods I
Fall. 4 credits. Prerequisite: some formal training in matrix algebra. Highly recommended: course at level of BTRY 417. R. N. Boisvert.
Comprehensive treatment of linear programming and its extensions, including postoptimality analysis. Topics include nonlinear programming, including separable, spatial equilibrium, and risk programming models. Discusses input-output models and their role in social accounting matrices and computable general equilibrium models. Makes applications to agricultural, resource, and regional economic problems.

AEM 713(7130) Dynamic Optimization
Spring. 3 credits. Prerequisite: ECON 609 and ECON 617. Letter grades only. J. M. Conrad.
Concerned with the solution of dynamic allocation problems. Objectives are to (1) pose prototype optimization problems in discrete and continuous time, (2) introduce the common methods for solving prototype problems, (3) present a set of numerical problems, and thereby (4) equip students with basic theory and methods to perform applied research on dynamic allocation problems.

AEM 714(7140) Experimental Economics
Fall. 4 credits. Prerequisite: ECON 609. Offered alternate years. W. D. Schulze.
Surveys both experimental economics methods and research as an approach to test economic theory. Students participate as subjects in a series of illustrative computerized experiments ranging from double auctions to public goods provision. Topics include experimental methods; decisions and games; markets (testing auction institutions); market power (monopoly, oligopoly); bargaining, compensation, and performance; public goods; externalities and voting; information and uncertainty; and economic anomalies. Students must design and write a paper describing their own experiment.

AEM 717(7170) Research Methods in Agricultural Economics
Spring. 2 credits. Prerequisite: graduate standing. R. N. Boisvert.
Discusses the research process and scientific method as applied in agricultural economics. Topics include problem identification, hypotheses, sources of data, sampling concepts and designs, methods of collecting data, questionnaire design and testing, field organization, and analysis of data. During the semester, each student develops a research proposal that may be associated with his or her thesis.

[AEM 730(7300) Seminar on International Trade Policy: Agriculture, Resources and Development
Spring. 3 credits. Prerequisite: graduate standing; AEM 630 or equivalent. Next offered 2008–2009. D. R. Lee.
Examines selected topics in the professional literature on international trade policy, focusing on agricultural trade and related topics, including trade liberalization, trade and environmental linkages, technological change and trade policy, and agricultural trade and development.]

AEM 735(7350) Public Finance: Resource Allocation and Fiscal Policy (also ECON 735[7350])
Spring. 4 credits. Prerequisite: ECON 609. R. Kanbur.
For description, see ECON 735.

AEM 744(7440) Advanced Consumer Research
Fall. 3 credits. Prerequisite: graduate standing; priority given to CALS Ph.D. students, especially in AEM, nutritional science, or food technology. B. Wansink.
Workshop providing students with a unique opportunity to develop an advanced theory-based understanding of consumers by using innovative methods and new research techniques. Class sessions alternate theory with implementation.

AEM 750(7500) Resource Economics
Fall. 3 credits. Prerequisites: ECON 609 and 618, or AEM 713. J. M. Conrad.
Uses optimal control and other methods of dynamic optimization to study the allocation and management of natural resources.

AEM 751(7510) Environmental Economics
Spring. 4 credits. Prerequisites: ECON 609 and graduate-level econometrics course. S-U or letter grades. G. L. Poe.
The objective of this course is to provide a graduate-level survey of the two prevailing contemporary themes in environmental economics: the measurement of the demand for environmental resources as input into benefit-cost analyses, and the design of incentive-based, cost-effective policy instruments to achieve environmental goals. Core topics include market failure, conceptual foundations for valuing changes in environmental quality, empirical applications of non-market valuation methods, and cost-effective market mechanism design for reducing pollution. Additional topics include information asymmetries and mechanism design for non-point source pollution, and international/global environmental issues.

[AEM 762(7620) Microeconomics of International Development
Fall. 3 credits. Prerequisite: completion of first-year Ph.D. course sequence in AEM or ECON or permission of instructor. S-U or letter grades. Next offered 2008–2009. C. B. Barrett.
Focuses on models of individual, household, firm/farm, and market behavior in low- and middle-income developing economies. Topics include agricultural land, labor, and financial institutions; technology adoption; food security and nutrition; risk management; intra-household analysis; reciprocity networks; and product/factor markets analysis. Emphasizes empirical research.]

AEM 765(7650) Development Microeconomics Graduate Research Seminar
Spring. 1–3 credits. Prerequisite: graduate standing and permission of instructor. C. B. Barrett.
Graduate students and the instructor present draft research proposals, papers, and

preliminary thesis results for group review and discussion. Students who actively participate by offering written and oral comments on others' work receive 1 credit. Students who also present their own proposal or paper receive 2 credits. Presentations last 75 minutes and thus represent a substantial investment of time. Students who present a second proposal or paper receive 3 credits.

AEM 800(8900) Master's-Level Thesis Research
Fall or spring. 1–9 credits. Prerequisite: permission of graduate committee chair. S-U grades only. Graduate faculty.
For students admitted specifically to a master's program.

AEM 900(9900) Graduate-Level Thesis Research
Fall or spring. 1–9 credits. Prerequisite: permission of graduate committee chair. S-U grades only. Graduate faculty.
For Ph.D. students **only before** "A" exam has been passed.

AEM 901(9910) Doctoral-Level Thesis Research
Fall or spring. 1–9 credits. Prerequisite: permission of graduate committee chair. S-U grades only. Graduate faculty.
For Ph.D. candidates *after* "A" exam has been passed.

ANIMAL SCIENCE

W. R. Butler, chair (149 Morrison Hall, 255-2862); R. E. Austic, D. E. Bauman, R. W. Blake, Y. R. Boisclair, D. L. Brown, L. E. Chase, D. J. R. Cherney, W. B. Currie, H. N. Erb, R. W. Everett, D. M. Galton, J. Gavalchin, P. Huhtanen, P. A. Johnson, X. G. Lei, Q. M. Long, T. R. Overton, J. E. Parks, A. N. Pell, E. J. Pollak, R. L. Quaas, S. M. Quirk, R. D. Smith, M. L. Thonney, M. E. Van Amburgh

AN SC 100(1000) Domestic Animal Biology I
Fall. 4 credits. S-U or letter grades. W. B. Currie.
Introduction to the biology of economically important species (morphology, anatomy, and physiology) and its application to the management of animals in major livestock industries. Topics include domestication and origins of animal science, anatomy, quantitative cell biology, regulatory mechanisms, public domain genetic databases, major life support systems, and digestion. Students undertake the care and management of several species of farm animals. Laboratory exercises include animal handling, examining aspects of anatomy, and small group discussions of contemporary biotechnologies. Living farm animals are used noninvasively, and fresh organs from dead animals are examined.

AN SC 105(1050) Contemporary Perspectives of Animal Science
Spring. 1 credit. Prerequisite: freshmen, sophomores, or first-year transfer standing. D. E. Bauman.
A forum to discuss the students' career planning and the contemporary and future role of animals in relation to human needs.

AN SC 110(1100) The Animals That Sustain Us: Lecture
Spring. 2 credits. S-U or letter grades. D. L. Brown.
Teaches the importance of the symbiosis between humans and domestic animals and how animal enterprises can be ethically, environmentally, and economically sound.

AN SC 111(1110) The Animals That Sustain Us: Lab
Spring. 1 credit. S-U or letter grades. D. L. Brown.
Teaches students to restrain and care for several species of domestic animals, including cats, dogs, sheep, cattle, goats, fish, and horses. Other species may be added according to student interest. Associated with AN SC 110 but may be taken separately.

AN SC 112(1120) Sustainable Animal Husbandry
Summer. 3 credits. S-U or letter grades. D. L. Brown.
Students completing this course will understand the many roles of domestic animals and the importance of their interdependence with humans; appreciate the scope, diversity, and problems related to domestic animal systems; be able to design and operate simple sustainable animal systems; and know how to continue learning about sustainable animal systems. This intensive summer course includes 25 hours of lecture and 39 hours of hands-on laboratory/demonstrations at various field sites and facilities all within a three-week period. Topics include domestication, sustainability, dogs, cats, rabbits, sheep, genetics, swine, nutrition, beef cattle, grazing, dairy cattle, dairy products, goats, poultry, aquaculture, camelids, horses, draft animals, animal systems modeling, Third World limited resource animal systems, toxicology, lab animals, toxicology, veterinary medicine, and ethics of human interactions with domestic animals.

AN SC 150(1500) Domestic Animal Biology II
Spring. 4 credits. S-U or letter grades. W. R. Butler and staff.
Second of a two-semester sequence (100/150) applying the basic biology and physiology of growth, defense mechanisms, reproduction, and lactation to life cycle aspects of the production and care of domestic animals. Uses fresh tissues and organs from dead animals along with preserved specimens in laboratories, exercises, and demonstrations. Uses a colony of Japanese quail for growth exercises, behavior, and data collection.

AN SC 204(2040) Sophomore Seminar: Domestic Animal Issues
Fall. 3 credits. S–U or letter grades. D. Brown.
Expression of discoveries, opinions, and solutions to problems in the area of domestic animal science and industry take on an extremely wide variety of forms. These expressions may include: the peer-reviewed journal article, summaries of scientific work for the public, grant writing for science, film, music, cowboy poetry, investigative journalism, web pages, online discussion groups, computer models and the conference. Topics used as points of reference for exposition of biological principles and for practicing those means of expression will vary, but for 2005–2006 included: roles animals play in society; BSE; vegetarianism; gender stereotypes and livestock; impact of animals on air and water quality; using hormones and antibiotics in food production; feral horses of the West.

AN SC 212(2120) Animal Nutrition
Fall. 4 credits. Prerequisite: CHEM 208 or equivalent. Recommended: AN SC 100 and 150. D. J. R. Cherney.
Introduction to animal nutrition, including digestive physiology and metabolism of domestic animals and other species; nutrient properties and requirements for different aspects of animal production and performance; principles of feed evaluation and ration formulation. Laboratory classes include gastrointestinal tract dissections and nutritional experiments performed on laboratory or farm animal species.

AN SC 215(2150) Exotic Avian Husbandry and Propagation
Fall. 2 credits. Limited to 100 students. Prerequisite: AN SC 100, 150, or one year introductory biology. J. Parks and D. Muscarella.
Natural history, care, management, health, and breeding of exotic avian species with emphasis on psittacines (parrots and related species) and raptors (birds of prey). Includes lectures, demonstrations, and local field trips.

AN SC 221(2210) Introductory Animal Genetics
Spring. 3 credits. Prerequisite: one year of college biology. E. J. Pollak.
Examination of basic genetic principles and their application to the improvement of domestic animals, with emphasis on the effects of selection on animal populations.

AN SC 250(2500) Dairy Cattle Principles
Fall. 3 credits. Prerequisite for AN SC 251, 351, 354, and 355. S-U or letter grades. D. M. Galton.
Introduction to the background and scientific principles relating to dairy cattle production. Laboratories are designed to provide an understanding of dairy cattle production.

AN SC 251(2510) Applied Dairy Cattle Genetics
Spring. 2 credits. Prerequisite: AN SC 250. S-U or letter grades. D. M. Galton.
Application of scientific principles of genetic programs in herds with different breeding programs. Emphasizes economical traits to be used to improve genetic progress and herd performance.

AN SC 265(2650) Horses
Fall. 3 credits. Prerequisites: AN SC 100 and 150 or permission of instructor. S-U or letter grades. C. Collyer.
Selection, management, feeding, breeding, and training of light horses.

AN SC 290(2900) Meat Science (also FD SC 290[2900])
Fall. 2 or 3 credits. Lec only, 2 credits; lec plus lab, 3 credits; lab cannot be taken without lec. Lab fee: $15. D. Shaw.
Introduction to meat science through a study of the structure, composition, and function of muscle and its conversion to meat. Also study properties of fresh and processed meat, microbiology, preservation, nutritive value, inspection, and sanitation. Laboratory exercises include anatomy, meat-animal slaughter, meat cutting, wholesale and retail cut identification, inspection, grading, curing, sausage manufacture, and quality control. An

all-day field trip to a commercial meat plant may be taken.

AN SC 300(3000) Animal Reproduction and Development
Spring. 3 credits. Prerequisite: AN SC 100–150 or equivalent or one year introductory biology. J. E. Parks.
Comparative anatomy and physiology of mammalian and avian reproduction, with emphasis on domestic and laboratory animals; fertilization through embryonic development, pregnancy, and growth to sexual maturity; emphasizes on physiological mechanisms and application to fertility regulation. Separate laboratory is offered to demonstrate fundamental aspects of reproduction and reproductive technology.

AN SC 301(3010) Animal Reproduction and Development Lab
Spring. 1 credit. Limited to 30 students per lab. Pre- or corequisite: AN SC 300. J. E. Parks.
Demonstrates fundamental principles and applied aspects of mammalian and avian reproduction. A limited number of live animals are used in some demonstrations. Dissection and examination of tissues from vertebrate animals are included in selected laboratories.

AN SC 305(3050) Farm Animal Behavior (also BIOAP 312[3120])
Spring. 2 credits. Prerequisites: one year introductory biology and introductory animal physiology (AN SC 100 and 150 or equivalent or BIOAP 311). Recommended: at least one animal production course or equivalent experience. S-U or letter grades. P. Perry.
The behavior of production species (avian and mammalian) influences the success of any management program. Students study behaviors relating to communication, learning, social interactions, reproduction, and feeding of domestic animals and their physiological basis. Management systems for commercial livestock production and their implications for animal behavior and welfare are stressed.

AN SC 310(3100) Introduction to Animal Welfare
Fall. 2 credits. S-U or letter grades. Staff.
Animal welfare issues will be discussed, mainly for farm animals, but companion animals will also be considered. Both animal specific and general areas of animal welfare will be discussed. This course will provide much of the background needed for Cornell to field a team and participate in the U.S. National Animal Welfare Judging contest in the spring.

[AN SC 341(3410) Biology of Lactation
Spring. 2 credits. Prerequisite: AN SC 100–150 or animal physiology course. Offered alternate years; next offered 2008–2009. Y. R. Boisclair.
Comprehensive survey of the biology of the mammary gland. Lectures cover (1) basic aspects such as anatomy and development of the mammary gland, biochemistry and hormone regulation of milk synthesis and regulation of gene expression in the mammary cells; (2) practical aspects such as the impact of lactation on nutrition, reproduction, and diseases. Lactation in the dairy cow provides the primary context, but examples from other mammals, including humans, are used.]

AN SC 351(3510) Dairy Herd Management
Spring. 4 credits. Prerequisite: AN SC 250 or permission of instructor. Recommended: AEM 302. D. M. Galton.
Application of scientific principles to practical herd management with components of reproduction, milking, housing, records, and production economics. Laboratories emphasize practical applications, analyses of alternatives, decision making, field trips, and discussion.

AN SC 354(3540) Dairy Cattle Herd Health
Fall. 3 credits. Prerequisite: AN SC 250 or permission of instructor. S-U or letter grades. K. Osborn.
Application of scientific principles to practical herd management with emphasis on herd health and animal well-being. Laboratory emphasizes practical applications of herd health management including on-farm herd health analysis.

AN SC 355(3550) Dairy Cattle Nutrition
Spring. 3 credits. Prerequisite: AN SC 250 or permission of instructor. Letter grades only. T. R. Overton.
Application of scientific principles to practical herd nutrition relating to herd production and feeding management. Laboratory emphasizes practical applications and field trips.

AN SC 360(3600) Beef Cattle
Spring. 3 credits. Offered even-numbered years. M. L. Thonney.
Emphasizes the management of reproduction, nutrition, and selection in beef cattle enterprises. Laboratories acquaint students with management skills through computerized simulations and working with cattle.

[AN SC 380(3800) Sheep
Spring. 3 credits. Offered odd-numbered years; next offered 2008–2009. M. L. Thonney.
Emphasizes the breeding, feeding, management, and selection of sheep from a production-system approach. Lectures and laboratories are designed to give students a practical knowledge of sheep production as well as the scientific background for improved management practices. Students work directly with sheep during laboratories and spend several days during the semester feeding and caring for ewes and their newborn lambs.]

AN SC 400(4000) Livestock in Tropical Farming Systems
Spring. 3 credits. Prerequisite: upperclass standing. R. W. Blake.
Comprises analyses of constraints on livestock production in developing countries of the tropics, economic objectives and risk, and methods of management. Emphasis is on strategic use of animal and plant resources, animal performance with inputs restricted, and decision making. Principles, field study, independent study projects and classroom interactions facilitate problem-solving to improve welfare of rural households.

AN SC 401(4010) Dairy Production Seminar
Spring. 1 credit. Prerequisite: senior standing. T. R. Overton.
Capstone course in which students, with the help of faculty members, complete a study of the research literature on topics of current interest in the dairy industry. Students then make an oral and a written report on their topic with emphasis on integrating theory and practice.

AN SC 402(4020) Seminar in Animal Sciences
Spring. 1 credit. Prerequisite: students engaged in undergraduate honors research projects. S-U or letter grades. S. Quirk.
Reports of undergraduate research and honors projects. Students present oral reports of their work for class discussion.

AN SC 410(4100) Nutritional Physiology and Metabolism
Fall. 3 credits. Prerequisites: biochemistry and physiology courses. R. E. Austic and D. E. Bauman.
Fundamental approach to nutrition focusing on the metabolic fate of nutrients and the interrelationships among nutrients, nutritional state, and metabolic processes. The overall goal is to increase understanding of metabolism and metabolic regulation through an integration of nutrition, biochemistry, and physiology.

AN SC 411(4110) Applied Cattle Nutrition
Fall. 4 credits. Designed for juniors, seniors, and entering graduate students. Prerequisites: AN SC 100 and 212 (or equivalent). Highly recommended: AN SC 355. M. E. Van Amburgh.
Integrates concepts of cattle nutrition and farm nutritional management to help students understand and appreciate factors influencing the performance of cattle under diverse conditions. Topics covered include: the effect of environment on maintenance costs; the nutrient requirements for various stages of growth, lactation, and pregnancy; rumen function, feed composition and chemistry, nutrient partitioning and the environmental impacts of cattle and how to minimize them. Computer models (Cornell Net Carbohydrate and Protein System) are used in the laboratory to actualize the information presented in lectures. Herd case studies are used in lab and there are field trips to farms to evaluate the nutritional management.

AN SC 412(4120) Whole-Farm Nutrient Management (also CSS 412[4120])
Spring. 2 or 4 credits. Prerequisite: junior, senior, or graduate standing; AN SC 411. Offered as two modules. Enrollment in Module 1 for first half of semester required (2 credits). Consists of crop and manure nutrient management planning; no prerequisites for CALS students. Enrollment in Module 2 for second half of semester is optional (additional 2 credits); builds on crop and manure nutrient management planning module by integrating agronomic nutrient management planning with herd nutrient management planning. Work on case studies outside lab. M. E. Van Amburgh and Q. M. Ketterings.
Provides students with an understanding of the concepts underlying whole farm nutrient management planning to improve profitability while protecting water and air quality. Students learn and apply concepts in the development of a Comprehensive Nutrient Management Plan (CNMP) that is required for a Concentrated Animal Feeding Operation plan to meet environmental regulations. Students develop components of a CNMP for a case study farm, using the Cornell University Nutrient Management Planning

System (*cu*NMPS) and other tools. All students enrolled learn the concepts and processes of developing the crop and manure nutrient management plan component of a CNMP during the first half of the semester in Module 1. Students opting to continue through the end of the semester in Module 2 (4-credit option) build upon knowledge gained in the first half of the semester by learning the knowledge and skills necessary to integrate crop production and herd feeding management for reducing nutrient imports on farms.

AN SC 414(4140) Ethics and Animal Science
Spring. 2 credits. Prerequisite: junior or senior standing. D. J. R. Cherney.
Explores the place of humans in the biological world, origins of ethics and morality, speciesism, the use of animals for research and agricultural purposes, transgenic animals. A book review, participation in discussion in class and online, and a project of the student's choice are used to evaluate the performance of each student.

AN SC 425(4250) Gamete Physiology and Fertilization (also BIOAP 425[4250])
Fall. 2 credits. Limited to 50 students. Prerequisite: AN SC 300 or equivalent. Offered alternate years. J. E. Parks.
Study formation, growth, differentiation, maturation, and transport of mammalian sperm and oocytes and cytological, physiological, and molecular changes required for fertilization.

AN SC 427(4270) Fundamentals of Endocrinology (also BIOAP 427[4270])
Fall. 3 credits. Prerequisite: animal or human physiology course or permission of instructor. P. A. Johnson.
Physiology and regulation of endocrine secretions. Emphasizes neuroendocrine, reproductive, growth, and metabolic aspects of endocrinology. Examples are selected from many animals, including humans.

AN SC 451(4510) Dairy Herd Business Management
Fall. 3 credits. Corequisite: AN SC 456. J. Karszes and D. M. Galton.
Emphasizes dairy herd business management with application to herd management analysis. Laboratory includes farm tours and analysis.

AN SC 456(4560) Dairy Management Fellowship
Spring. 2 credits. Prerequisites: senior standing; AN SC 351; permission of instructor. S-U grades only. D. M. Galton.
Designed for undergraduates who have a sincere interest in dairy farm management. Objective is to gain further understanding of the integration and application of dairy farm management principles and programs with respect to progressive dairying and related industries.

AN SC 457(4570) Introductory Spanish for Dairy Producers
Spring. 3 credits. Prerequisite: AN SC 250 or permission of instructor. S-U or letter grades. K. Osborn.
Students with a focus on dairy management learn to communicate with the increasingly Spanish-speaking workforce to assure that the knowledge of cutting-edge dairy management and observations from the field are exchanged accurately. This is the first of a sequence of two courses developed to meet these goals.

AN SC 458(4580) Advanced Spanish for Dairy Producers
Fall. 3 credits. Prerequisite: AN SC 457 or permission of instructor. S-U or letter grades. K. Osborn.
Students with a focus on dairy management need to be able to communicate with the Spanish-speaking workforce, and upward mobility of that workforce depends on knowledge of cutting-edge dairy management. This is the second course of a two-sequence program that will further develop the students' skills to be able to communicate in Spanish higher-level dairy production tasks and principles to Spanish-speaking dairy workers.

AN SC 470(4700) Merchandizing Beef Cattle
Fall. 2 credits. S-U or letter grades. M. J. Baker.
Introduction to the merchandizing of replacement beef heifers. Topics of study will include budgeting, advertising, animal preparation, cataloging, clerking and reporting. Students will gain practical knowledge through lecture as well as hands on experience by planning, organizing and conducting a sale of bred beef heifers from the Empire Heifer Development Program.

AN SC 494(4940) Special Topics in Animal Science
Fall or spring. 4 credits max. Prerequisite: undergraduate standing. S-U or letter grades. Staff.
The department teaches "trial" courses under this number. Offerings vary by semester and are advertised by the department before the semester begins. Courses offered under the number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

AN SC 496(4960) Internship in Animal Science
Fall or spring. 1–3 credits, variable; 6 credits max, during undergraduate career. Students must register using independent study form (available in 140 Roberts Hall). S-U grades only. Staff.
Structured, on-the-job learning experience under supervision of qualified professionals in a cooperating organization (e.g., farm, agribusiness, pharmaceutical company, zoo, educational institution). Internships are arranged by the student and must be approved in advance by the student's academic advisor. The internship should provide a professionally supervised experience with at least 60 hours on the job per credit required.

AN SC 497(4970) Individual Study in Animal Science
Fall or spring. 1–3 credits, variable; may be repeated for credit. Intended for students in animal sciences. Prerequisite: permission of instructor. Students must register using independent study form (available in 140 Roberts Hall). S-U or letter grades. Staff.
May include individual tutorial study or a lecture topic selected by a professor. Because topics may change, the course may be repeated for credit.

AN SC 498(4980) Undergraduate Teaching
Fall or spring. 1–3 credits, variable; limited to two experiences during undergraduate career. Prerequisite: GPA of at least 2.7. Students must register using independent study form (available in 140 Roberts Hall).
Designed to consolidate the student's knowledge. A participating student assists in teaching a course allied with his or her education and experience. The student is expected to meet regularly with a discussion or laboratory section, to gain teaching experience, and regularly to discuss teaching objectives, techniques, and subject matter with the professor in charge.

AN SC 499(4990) Undergraduate Research
Fall or spring. 6 credits max. during undergraduate career. Prerequisite: junior or senior standing; GPA of at least 2.7. Not open to students who have earned 6 or more undergraduate research credits elsewhere in the college. Students must register using independent study form (available in 140 Roberts Hall).
Affords opportunities for students to carry out independent research under appropriate supervision. Each student is expected to review pertinent literature, prepare a project outline, conduct the research, and prepare a report.

[AN SC 603(6030) Mineral Nutrition: Metabolic, Health, and Environmental Aspects (also NS 603[6030])
Fall. 2 credits. Prerequisites: biochemistry, physiology, and nutrition courses. Letter grades only. Offered alternate years; next offered 2008–2009. X. G. Lei and C. C. McCormick.
Emphasizes metabolism, gene regulation, antioxidation, and genetic defects related to mineral nutrition. Team-taught lectures cover topics ranging from single gene mutation to social and environmental aspects of mineral nutrition and mineral-related disorders. Discusses effective approaches to improve global mineral nutrition by agriculture and food systems.]

AN SC 606(6060) Ruminant Nutrition: Microbial Ecology and Forage Chemistry
Spring. 4 credits. Prerequisites: AN SC 212, biochemistry course; senior or graduate standing or permission of instructor. S-U or letter grades. Offered alternate years. P. Huhtanen.
Provides an overview of ruminant nutrition with an emphasis on microbial ecology, forage chemistry, and rumen function.

AN SC 610(6100) Animal Science Seminar
Fall and spring. 1 credit. Prerequisite: graduate standing. S-U grades only. X. G. Lei.
Weekly seminar on topics related to animal science. The requirement for an S grade is regular attendance at seminars during the semester.

AN SC 619(6190) Field of Nutrition Seminar (also NS 619[6190])
Fall and spring. 0 credits. No grades given.
For description, see NS 619.

AN SC 621(6210) Reproductive Physiology/Endocrinology Seminar
Fall and spring. 1 credit. Prerequisite: graduate standing or permission of instructor. S-U grades only. W. R. Butler and staff.
Current research in reproductive physiology is presented by faculty and staff members, graduate students, and invited speakers.

AN SC 622(6220) Seminar in Animal Metabolism
Fall and spring. 1 credit. Prerequisite: permission of instructor. S-U grades only. Y. R. Boisclair and D. E. Bauman.
Current issues in metabolism are discussed as they relate to productivity, well-being, and diseases of animals. Students present research proposals for new initiatives, progress reports on ongoing projects and recent peer-reviewed publications of high significance.

AN SC 694(6940) Special Topics in Animal Science
Fall or spring. 4 credits max. Prerequisite: graduate standing. S-U or letter grades.
The department teaches "trial" courses under this number. Offerings vary by semester and are advertised by the department before the semester begins. Courses offered under the number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

AN SC 800(8900) Master's-Level Thesis Research
Fall or spring. Credit TBA, max. 12 per semester. Prerequisite: permission of advisor. S-U grades only. Graduate faculty.
For students admitted specifically to a master's program.

AN SC 900(9900) Graduate-Level Thesis Research
Fall or spring. Credit TBA, max. 12 per semester. Prerequisite: permission of advisor. S-U grades only. Graduate faculty.
For students in a Ph.D. program *only before* "A" exam has been passed.

AN SC 901(9910) Doctoral-Level Thesis Research
Fall or spring. Credit TBA, max. 12 credits per semester. Prerequisite: permission of advisor. S-U grades only. Graduate faculty.
For students admitted to candidacy *after* "A" exam has been passed.

Related Courses in Other Departments

Introductory Animal Physiology (BIOAP 311)

Animal Physiology Experimentation (BIOAP 319)

Milk Quality (FD SC 351)

Agriculture in the Developing Nations (IARD 602)

Lipids (NS 602)

Basic Immunology Lectures (BIO G 305)

BIOLOGICAL AND ENVIRONMENTAL ENGINEERING

M. F. Walter, chair (104 Riley-Robb Hall; 255-2270, -2465); B. A. Ahner, L. D. Albright, D. J. Aneshansley, A. J. Baeumner, J. A. Bartsch, A. K. Datta, K. G. Gebremedhin, R. C. Gorewit, D. A. Haith, P. Hess, J. B. Hunter, L. H. Irwin, W. J. Jewell, D. Luo, J. C. March, J.-Y. Parlange, N. R. Scott, R. M. Spanswick, T. S. Steenhuis, M. B. Timmons, L. P. Walker, M. T. Walter. Lecturers: C. L. Anderson, T. J. Cook, L. D. Geohring, P. E. Hillman

BEE 110(1030) Introduction to Metal Fabrication Techniques
Spring. 3 credits. Limited to 20 students per lab. Letter grades only. T. J. Cook.
Emphasis is on selection of proper materials and techniques to accomplish a variety of metal fabrication and maintenance projects. Covers hand and machine tools, fasteners, strengths of materials, classification and identification of metals, sheet metal work, soldering, pipe fitting, forging, controlling distortion, oxy-acetylene torch cutting, welding and brazing, carbon steel stick arc welding, arc cutting and use of the carbon arc torch.

BEE 132(1040) Introduction to Wood Construction
Fall. 3 credits. Limited to 16 students per lab. Letter grades only. T. J. Cook.
Principles and practice of wood construction. Covers site selection and preparation, drainage, water and septic development, footers and foundations, concrete work and block construction, material properties, framing and roofing, comparison of alternatives to wood construction, use of hand and power tools, wood joining methods and joinery, fasteners and their application. Each student plans and constructs an approved carpentry project (fine furniture to livestock equipment that will be useful, durable, and show the students ability and mastery of the subject matter).

BEE 151(1510) Introduction to Computer Programming
Fall. 4 credits. Limited to 18 students per lab and rec. No previous programming experience assumed. Pre- or corequisite: MATH 191 or equivalent. Letter grades only. C. L. Anderson.
Introduction to computer programming and concepts of problem analysis, algorithm development, and data structure in an engineering context. The structured programming language MATLAB is used, implemented on interactive personal computers and applied to problems of interest in biological and environmental engineering.

BEE 200(1200) The BEE Experience
Spring. 1 credit. Requirement for CALS BEE freshmen. Not required for students who have completed ENGRG 150. Prerequisite: BEE majors or permission of instructor. Letter grades only. J. A. Bartsch.
Forum covering the career opportunities for engineering students and the activities and curricula that lead to these opportunities. A series of seminars are given by practicing engineers, Cornell faculty members, alumni, staff from Cornell career services offices, and students. Students develop their undergraduate course plans, complete a web search assignment to locate jobs and internships, and select future courses to meet their academic objectives and career goals.

BEE 222(2220) Bioengineering Thermodynamics and Kinetics
Spring. 3 credits. Prerequisites: MATH 192, BIO G 110, PHYS 213, and chemistry course completed or concurrent. Letter grades only. J. B. Hunter.
Living systems rely on chemical and phase equilibria, precise coordination of biochemical pathways, and the release of chemical energy as heat, all of which are governed by the laws of thermodynamics and the rates of chemical reactions. The course covers concepts and laws of thermodynamics as applied to phase transformations, work, heat, and chemical reactions; and reaction kinetics applied to industrial processes and living systems, all with a focus on biological examples.

BEE 251(2510) Engineering for a Sustainable Society (also ENGRD 251[2510])
Fall. 3 credits. Pre- or corequisite: MATH 293. Letter grades only. B. A. Ahner.
Case studies of contemporary environmental issues including pollutant distribution in natural systems, air quality, hazardous waste management, and sustainable development. Emphasis is on the application of math, physics, and engineering sciences to solve energy and mass balances in environmental sciences. Introduces students to the basic chemistry, ecology, biology, ethics, and environmental legislation relevant to the particular environmental problem. BEE students must complete either BEE 251 or BEE 260 according to their academic plan. BEE students who complete both BEE 251 and BEE 260 receive engineering credit for only one of these courses.

BEE 260(2600) Principles of Biological Engineering (also ENGRD 260[2600])
Fall. 3 credits. Pre- or corequisite: MATH 293. Letter grades only. J. B. Hunter.
Focuses on the integration of biological principles with engineering, math, and physical principles. Students learn how to formulate equations for biological systems in class and practice in homework sets. Topics range from molecular principles of reaction kinetics and molecular binding events to macroscopic applications such as energy and mass balances of bioprocessing and engineering design of implantable sensors. BEE students must complete either BEE 251 or BEE 260 according to their academic plan. BEE students who complete both BEE 251 and BEE 260 receive engineering credit for only one of these courses.

BEE 299(3299) Sustainable Development: A Web-Based Course
Spring, summer. 3 credits. Prerequisite: at least sophomore standing. S-U or letter grades. N. R. Scott.
Sustainable development is the dominant economic, environmental, and social issue of the 21st century. This course develops the concepts of sustainable development as an evolutionary process, demanding the integration of the physical sciences and engineering with the biological and social sciences for design of systems. Topics include the nature of ecosystems, global processes, sustainable communities, and industrial ecology and life cycle analysis.

BEE 305(3050) Principles of Navigation (also NAV S 301[3050])
Spring. 4 credits. Three classes each week (lec-rec-project work). Letter grades only. Lt. Gamicchia.
Introduction to the fundamentals of marine navigation emphasizing piloting and celestial navigation procedures. Covers coordinate systems, chart projections, navigational aids, instruments, compass observations, time, star identification, use of the nautical almanac, tides, and currents. Also *briefly* discusses electronic navigation systems.

BEE 310(1050) Advanced Metal Fabrication Techniques
Spring. 1 credit; 2-credit option available. Prerequisite: BEE 110 or permission of instructor. Letter grades only. T. J. Cook.
Principles and practices beyond the scope of BEE 110. Includes out-of-position, low-hydrogen, high-carbon steel and cast iron welding. Topics such as soldering and brazing of aluminum, hard surfacing, both tungsten (TIG) and metallic (MIG) inert gas welding, plasma-arc, and oxy cutting of metals are covered. Planning, development, and fabrication of a metal construction project is required for the 2-credit option.

BEE 331(3310) Bio-Fluid Mechanics
Fall. 4 credits. Prerequisites: ENGRD 202 and Engineering math sequence. Letter grades only. K. G. Gebremedhin.
Properties of Newtonian and non-Newtonian fluids; hydrostatic and dynamic forces; principles of continuity, conservations of mass, energy and momentum and their applications; laminar and turbulent flows and boundary layer, introduction to Navier Stokes; dimensional analysis and similarity; blood flow in the cardiovascular system; gas exchange in the pulmonary system; blood flow and sodium transport in the kidney.

BEE 350(3500) Biological and Environmental Transport Processes
Fall. 3 credits. Pre- or corequisites: MATH 293 and fluid mechanics course. Letter grades only. A. K. Datta.
Focuses on understanding the principles of heat and mass transfer in the context of biological, biomedical, and environmental systems. Emphasizes physical understanding of transport processes and simple reaction rates with application examples from plant, animal, and human biology, the environment (soil/water/air), and industrial processing of food and biomaterials.

BEE 360(3600) Molecular and Cellular Bioengineering (also BME 360[3600])
Spring. 3 credits. Prerequisite: BEE 260, biochemistry, linear algebra, ordinary differential equations, or permission of instructor. Letter grades only. J. March.
Biotechnology viewed at the cellular and molecular level. Advances in biotechnology will be broken down to their functional parts using the tools of biological engineering (thermodynamics, transport, kinetics, etc.) to understand how and why they work with an emphasis on design. Particular attention paid to gene therapy, synthetic biology, protein engineering, and nucleic acid engineering. Case studies in biomedical, bioprocess, and bioenvironmental engineering.

BEE 362(3620) Fundamentals of Tissue Engineering
Spring. 3 credits. Limited to 25 students; priority given to graduating seniors. Prerequisites: biochemistry, BEE 350. Letter grades only. R. C. Gorewit.
Biochemical and physiological fundamentals of tissue engineering. Cell technology, cell function in constructs and sources of cells for tissue engineering. Biomaterials, including functional requirements, biomimetics and substrates, and bioartificial construct technology. Diffusion and transport processes in engineered tissue, manufacture and scale-up of production processes, regulation and FDA approval of engineered products. Examples include cartilage, bone, skin, cardiovascular and neural tissues.

BEE 365(3650) Properties of Biological Materials
Spring. 3 credits. Satisfies BEE laboratory experience requirement. Pre- or corequisite: ENGRD 202. Letter grades only. J. A. Bartsch.
Mechanics and structural properties of biological materials; mechanical testing of animal, plant, and food products. Laboratory exercises involve quasistatic and dynamic testing of materials and interpretation of test results. Uses experimental techniques to determine engineering properties of these materials.

BEE 368(3680) Biotechnology Applications: Animal Bioreactors
Fall. 3 credits. Prerequisite: biochemistry course or permission of instructor. Letter grades only. R. C. Gorewit.
Introduces students to the biotechnological applications of animals; their organs, tissues, and cells as bioreactors for the production of substances such as pharmaceuticals; growth factors, anti-tumor proteins, antibodies, and vaccines. Exposes students to various design issues, technical constraints, societal concerns, and ethical considerations of this biotechnology.

[BEE 371(3710) Physical Hydrology for Ecosystems
Spring. 3 credits. Prerequisite: MATH 192 or permission of instructor. Letter grades only. Offered alternate years; next offered 2008–2009. T. S. Steenhuis and M. T. Walter.
This is an introduction to fundamental hydrology emphasizing physical hydrological processes and the roles of interactions among hydrology, ecology, biogeochemistry, and human activities. This course focuses on surface and near surface processes and introduces deeper, groundwater-hydrology. A broad range of specific topics is covered: e.g., the hydrologic cycle, watershed hydrology, runoff generation, physical and biophysical vadose zone processes, erosion and sediment transport, and eco-hydrological systems.]

BEE 401(4010) Renewable Energy Systems
Spring. 3 credits. Prerequisite: college physics. Letter grades only. L. D. Albright.
Introduces energy systems with emphasis on quantifying costs and designing/optimizing renewable energy systems to convert environmental inputs into useful forms of energy. Covers solar energy, small-scale hydropower, wind, bio-conversion processes, house energy balances. Focuses on the technologies and small-scale system design, not policy issues. Use of spreadsheets is extensive.

BEE 427(4270) Water Sampling and Measurement
Fall. 3 credits. Satisfies BEE laboratory experience requirement. Prerequisites: fluids or hydrology course and MATH 191. Letter grades only. L. D. Geohring and T. S. Steenhuis.
Get wet and muddy with this course on water measurement sampling methods where science and engineering technologies are integrated to quantify, characterize, and analyze environmental engineering problems. This field-based lab course focuses on quantification of surface and subsurface water flow and quality, utilizing various measurement equipment and analytical techniques. Quality assurance protocols and interpretation of watershed contaminants are addressed.

BEE 435(4350) Principles of Aquaculture
Spring. 3 credits. Satisfies BEE capstone design requirement when co-registered in BEE 496. Prerequisite: at least junior standing. Letter grades only. Two required field trips require class to return to campus at 7 p.m. M. B. Timmons.
An in-depth treatment of the principles of aquaculture: fish biology, waste treatment, engineering design, fish health, nutrition, processing, etc. This course is intended to build upon the undergraduate's previous course background and interests. Includes supervised "hands-on" laboratory experiences.

BEE 450(4500) Bioinstrumentation
Spring. 4 credits. Satisfies both BEE laboratory experience and BEE capstone design requirement. Satisfies College of Engineering technical writing requirement when co-registered in BEE 493. Prerequisites: MATH 294, introductory computing, two semesters of physics, statistics or permission of instructor. Letter grades only. D. J. Aneshansley.
Bioinstrumentation applications are emphasized in this laboratory-based course. Electronic instruments from sensor to computer are considered. Static and dynamic characteristics of components and systems are examined theoretically and empirically. General analog and digital signal condition circuits are designed, constructed, and tested. A variety of biological applications of instrumentation are discussed.

BEE 453(4530) Computer-Aided Engineering: Applications to Biomedical Processes (also M&AE 453[4530])
Spring. 3 credits. Satisfies BEE capstone design requirement. Prerequisite: heat and mass transfer (BEE 350 or equivalent). Letter grades only. A. K. Datta.
Introduction to simulation-based design as an alternative to prototype-based design; analysis and optimization of complex real-life processes using industry-standard physics-based computational software high-end personal computer. Covers biomedical processes and industrial food processing applications of heat and mass transfer. Computational topics introduce the finite-element method, pre- and post-processing, and pitfalls of using computational software. Students choose their own term project, which is the major component of the course (no final exam).

BEE 454(4540) Physiological Engineering
Fall. 3 credits. Satisfies BEE laboratory experience requirement. Prerequisites: differential equations, 2 semesters of physics, introductory biology, statistics. Letter grades only. D. J. Aneshansley.
This course examines engineering measurements of biological systems and mathematical models of animal physiology. Membrane transport, sensory organs (vision, hearing), and interacting systems (respiratory and cardio-vascular systems) are investigated in laboratory experiments and problem sets associated with the laboratories. Engineering mathematics (differential equations, Fourier transforms, and Laplace transforms) are used to model and analyze physiological systems. Laboratories include wet laboratory measurements of red blood cell volume, reaction times and nerve conduction, sound production and analysis, color and spatial frequency tests of human vision, construction of a temperature controlled pacemaker circuit, use of telemetry to monitor heart rate during exercise, and design of a spirometer to measure respiratory function.

[BEE 459(4590) Biosensors and Bioanalytical Techniques
Fall. 3 credits. Prerequisites: biochemistry course and permission of instructor. Letter grades only. Next offered 2008–2009. A. J. Baeumner.
Provides students with an understanding of the scientific and engineering principles of biosensors and bioanalytical techniques. Addresses selected topics from simple biosensors to micro/nanofabricated Micro Total Analysis Systems (MicroTAS). Biosensor and Micro TAS applications in environmental analysis, food safety, and medical diagnostics are explored. Students give oral presentations in lecture, analyze biosensors published in literature, and theoretically design a biosensor based on criteria discussed in class. Undergraduate students work together in teams of two to three. Meets concurrently with BEE 659. BEE 659 students work independently on individual biosensor projects.]

[BEE 464(4640) Bioseparation Processes
Fall. 3 credits. Prerequisites: introductory biochemistry, physics, MATH 192, BEE 260 or equivalent, or permission of instructor. Next offered 2008–2009. S-U or letter grades. J. B. Hunter.
Bioseparation is the science and engineering of fractionating and purifying biological materials: DNA, proteins, living cells, antibiotics, biofuels, and even foods. This course covers separation methods used in the biotechnology industry, principles governing these methods, approaches to improving bioseparation performance, and the special challenges of scale-up. Key topics (centrifugation, filtration, extraction, membrane methods, ion exchange, chromatography, electrophoresis) are supplemented with student presentations. Intended for seniors and graduate students in engineering, chemistry, biology, and food science.]

BEE 471(4710) Introduction to Groundwater (also EAS 471[4710])
Spring. 3 credits. Prerequisites: MATH 293, fluid mechanics or hydrology course. S-U or letter grades. Field trip. L. M. Cathles and T. S. Steenhuis.
Intermediate-level study of aquifer geology, groundwater flow, and related design factors. Includes description and properties of natural aquifers, groundwater hydraulics, soil water, and solute transport.

BEE 473(4730) Watershed Engineering
Fall. 3 credits. Satisfies BEE capstone design requirement when co-registered in BEE 496. Satisfies College of Engineering technical writing requirement when co-registered in BEE 493. Satisfies BEE laboratory experience requirement. Prerequisite: fluid mechanics or hydrology course. Letter grades only. M. T. Walter.
This course teaches basic design and analysis as practiced for water control and nonpoint source pollution prevention. We will discuss the origins of design approaches including their theoretical bases but this is not a theory course. Most of the course is dedicated to practicing applied design. Assignments are generally representative of real-life engineering problems and will involve as much hands-on experience as possible. Some example topics include risk analysis, water conveyance, nonpoint source pollution control, stream restoration, stormwater management, and erosion control.

BEE 474(4740) Water and Landscape Engineering Applications
Spring. 3 credits. Satisfies BEE capstone design requirement. Prerequisites: fluids or hydrology course or permission of instructor. Letter grades only. T. S. Steenhuis and L. D. Geohring.
This course will focus on how water moves in soil and the implications for design of drainage and irrigation systems in the landscape. The course addresses aspects of soil physics, flow in porous media, water quality and water supply or disposal in regard to drainage and irrigation applications. Emphasis is on problem solving of actual situations, and a major site-design project is required.

BEE 475(4750) Environmental Systems Analysis
Fall. 3 credits. Prerequisites: computer programming and one year of calculus. Letter grades only. D. A. Haith.
Applications of mathematical modeling, simulation, and optimization to environmental-quality management. Fate and transport models for contaminants in air, water, and soil. Optimization methods (search techniques, linear programming) to evaluate alternatives for solid-waste management and water and air pollution control. Introduction to hydrologic simulation (runoff and streamflow). Software packages for watershed analyses of point and nonpoint source water pollution.

BEE 476(4760) Solid Waste Engineering
Spring. 3 credits. Prerequisites: one semester of physics and chemistry. Letter grades only. D. A. Haith.
Planning and design of processes and facilities for management of municipal solid wastes. Source characterization and reduction; collection and transport systems; waste-to-energy combustion; sanitary landfills; composting; recycling, and materials recovery facilities; and hazardous waste management. Emphasizes quantitative analyses.

BEE 478(4780) Ecological Engineering
Spring. 3 credits. Satisfies BEE capstone design requirement when co-registered in BEE 496. Prerequisite: junior-level environmental quality engineering course or equivalent. Letter grades only. W. J. Jewell.
Ecological engineering is the language of sustainable living. Waste management with natural systems, the most advanced form of this new engineering direction, includes constructed wetlands, hydroponic applications of plants in resource-recovery waste management systems, soil restoration, phytoremediation, and bioremediation of toxics. Biomass refineries to create energy-independent communities, sustainable drinking water systems, carbon sequestration, and zero polluting farms are future sustainable living topics that also solve some of society's larger problems.

BEE 481(4791) LRFD-Based Engineering of Wood Structures (also CEE 481[4791])
Spring. 3 credits. Satisfies BEE capstone design requirement when co-registered in BEE 496. Prerequisite: ENGRD 202. Letter grades only K. G. Gebremedhin.
Computer-aided and manual computation procedures of Load and Resistance Factor Design (LRFD)–based engineering of wood structures. National design codes and standards; estimation of factored design loads and load combinations; mechanical properties of wood and wood products; designs of beams, columns; trusses, frames, arches, bridges, diaphragms; connections and wood structural systems. Also discusses engineering design judgment as an integral component of the quantitative design procedure.

BEE 484(4840) Metabolic Engineering
Spring. 3 credits. Prerequisite: biochemistry course or permission of instructor. Letter grades only. R. M. Spanswick.
The principles of metabolic engineering as they relate to the regulation of metabolic pathways, including membrane transport, are considered in terms of enzyme kinetics and metabolic control analysis. Case studies, reflecting the interests of the instructor, include examples involving higher plants. Each student is expected to investigate one topic in depth and make a short class presentation.

BEE 487(4870) Sustainable Energy Systems
Fall. 3 credits. Satisfies BEE capstone design requirement. Intended for upper-level undergraduates and graduate students. Prerequisites: BEE 350 and thermodynamics course. Letter grades only. N. R. Scott and L. D. Albright.
Offers a systems approach to understanding renewable energy systems (solar, wind, and biomass) and their conversion processes, from various aspects of biology, physics, engineering, environmental impacts, economics, and sustainable development.

BEE 489(4890) Engineering Entrepreneurship, Management, and Ethics
Spring. 4 credits. Satisfies College of Engineering technical writing requirement. Prerequisites: junior standing; ENGRD 270 or CEE 304 or equivalent highly recommended. Letter grades only. M. B. Timmons and R. Evans.

The course focuses on how to start a new company centered on engineering or biological technologies. Course objectives include coverage of: entrepreneurship principles, fund raising, negotiation, financial calculations (internal rate of return, time value of money, proforma statements); legal structures of businesses; project management; and to develop an awareness of issues related to professional ethics; and technical writing and communication. Majority of work done in teams including a complete business plan that is presented to angel investors. Business plans must require less than $100K in startup funding and may result in actual investment by the angel investor group.

BEE 493(4930) Technical Writing for Engineers

Fall or spring. 1 credit. Meets College of Engineering technical writing requirement when taken concurrently with BEE 473 in fall or BEE 450 in spring. Letter grades only. Staff.

Covers communication skills necessary for oral and written technical project reports. Also considers outlines, style, audience, and general presentation mechanics.

BEE 494(4940) Special Topics in Biological and Environmental Engineering

Fall or spring. 4 credits max. S-U or letter grades. Staff.

The department teaches "trial" courses under this number. Offerings vary by semester and will be advertised by the department. Courses offered under this number will be approved by the department curriculum committee and the same course will not be offered twice under this number. Each 494 has a unique course ID for enrollment.

BEE 494(4940) Baja SAE (also M&AE 490, section 58)

Fall, spring. 1–4 credits. Prerequisite: permission of instructor. No evening prelims. Letter grades only. L. Collins.

Design and build off-road vehicle for Society of Automotive Engineers competition.

BEE 494(4940) Introduction to Atmospheric Chemistry

Fall. 3 credits. Engineers must take for letter grade. Prerequisites: one year of chemistry, one year of calculus, one year of calculus-based physics or permission of instructor. S-U or letter grades. P. Hess.

Quantitative discussion of the basic processes that control the composition of the earth's atmosphere and the relationship of these processes to air pollution and climate change.

BEE 495(4950) BEE Honors Research

Fall or spring. 1–6 credits, variable. Prerequisite: enrollment in BEE research honors program. Students must be eligible for Latin honors and complete honors program application by third week of fall semester, senior year. Letter grades only. Staff.

Intended for students pursuing the research honors program in BEE.

BEE 496(4960) Capstone Design in Biological and Environmental Engineering

Fall or spring. 1 credit. Corequisite: one approved upper-level course (BEE 435, 473, 478, 481). Letter grades only. Staff.

Involves capstone design experience, including a team project incorporating analysis, design, evaluation, synthesis, and a written and oral report of the end product.

BEE 497(4970) Individual Study in Biological and Environmental Engineering

Fall and spring. 1–4 credits. Prerequisite: written permission of instructor and adequate ability and training for work proposed; normally reserved for seniors in upper two-fifths of their class. Students from all colleges must register using independent study form (available in 207 Riley-Robb Hall). Letter grades only. See department office for course ID specific to your project advisor. Staff.

Special work in any area of biological and environmental engineering on problems under investigation by the department or of special interest to the student, provided, in the latter case, that adequate facilities can be obtained.

BEE 498(4980) Undergraduate Teaching

Fall and spring. 1–4 credits. Prerequisite: written permission of instructor. Letter grades only. Students from all colleges must register using independent study form (available in 207 Riley-Robb Hall). See department office for course ID specific to your project advisor. Staff.

The student assists in teaching a biological and environmental engineering course appropriate to his or her previous training. The student meets with a discussion or laboratory section, prepares course materials, grades assignments, and regularly discusses objectives and techniques with the faculty member in charge of the course.

BEE 499(4990) Undergraduate Research

Fall and spring. 1–4 credits. Prerequisites: normally reserved for seniors in upper two-fifths of their class; adequate training for work proposed; written permission of instructor. Letter grades only. Students from all colleges must register using independent study form (available in 207 Riley-Robb Hall). See department office for course ID specific to your project advisor. Staff.

Research in any area of biological or environmental engineering on problems under investigation by the department or of special interest to the student, provided that adequate facilities can be obtained. The student must review pertinent literature, prepare a project outline, carry out an approved plan, and submit a formal final report.

BEE 501(5010) Bioengineering Seminar (also BME 501[5010])

Fall, spring. 1 credit. Prerequisite: junior, senior, or graduate standing. S–U grades only. D. Lipson.

To give you, the engineer-in-training, a *broad* overview of different aspects of biological and biomedical engineering including business, legal, and clinical issues. To give the students a working knowledge of how abstracts are written and revised.

BEE 520(5900) M.P.S. Project

Fall and spring. 1–6 credits. Requirement for each M.P.S. candidate in field. Letter grades only. BEE graduate faculty.

Comprehensive project emphasizing the application of agricultural technology to the solution of a real problem.

BEE 533(5330) Engineering Professionalism

Spring. 1 or 2 credits*. Prerequisite: graduate student with accredited engineering degree or senior who will graduate with accredited engineering degree. Must register to take Fundamentals of Engineering Exam.** S-U or letter grades. M. B. Timmons, J. R. Stedinger, other Engineering Faculty.

Presentations address engineering professionalism and ethics, and provide preparation for the general NY FE Examination taught in a team-based format. The course emphasizes the engineer's professional responsibilities for the health and welfare of the public and the guiding principles for a professional engineer. Case histories on engineering ethics will be examined and students will write their own personal statement addressing integrity. Homework addresses FE exam preparation, and students complete the formal comprehensive review of engineering subjects associated with the Fundamentals of Engineering Exam.

*1-credit option includes FE review only.

**Students must file their N.Y. FE Exam application by either November 1 of the previous year or by May 1 of the spring semester to be enrolled in BEE 533. The FE exam registration and sitting fees total $195 and are paid to the N.Y. State Education Department and the testing service, not to Cornell. The N.Y. FE Exam is offered in April and October; the April exam may be taken at Cornell and other N.Y. locations; the October exam is not offered at Cornell.

BEE 551(5950) Master of Engineering Design Project

Fall and spring. 3–6 credits. Prerequisite: admission to M.Eng. degree program. Letter grades only. BEE graduate faculty.

Comprehensive engineering design projects relating to the candidate's area of specialization. Projects are supervised by faculty members on an individual basis. A formal project report and oral presentation of the design project are required for completion of the course(s). A minimum of 3 to a maximum of 12 credits of 551 is required for the M.Eng. degree (can be taken in two semesters).

BEE 647(6470) Water Transport in Plants (also BIOPL 651[6510])

Fall. 2 credits. Letter grades only. Offered alternate years. R. M. Spanswick.

Topics include water relations of plant cells and tissues using water potential terminology; permeability of plant cells to water and the role of aquaporins; transport of water through whole plants, including transpiration, stomatal physiology, and the modifications due to plant communities; water status and plant growth in relation to water stress.

[BEE 649(6490) Solute Transport in Plants (also BIOPL 649[6490])

Fall. 3 credits. Letter grades only. Offered alternate years; next offered 2008–2009. R. M. Spanswick.

Fundamental treatment of the transport of ions and small organic molecules in plants. Topics include electrophysiology of cell membranes, including ion channels and electrogenic ion pumps; transport mechanisms for the major ions; intercellular and long-distance ion transport; cotransport

systems for sugars and amino acids; phloem transport; ABC-type transporters.]

BEE 651(6510) Bioremediation: Engineering Organisms to Clean Up the Environment
Spring. 3 credits. Prerequisites: BIOMI 290 or BIOBM 331 or permission of instructor. Letter grades only. B. A. Ahner.
Examines ways in which organisms may be used to remove or metabolize pollutants in the environment, including bacterial degradation of organics and phytoremediation of heavy metals. Through lectures and current literature, students evaluate the benefits as well as the current obstacles. Examines the current efforts to genetically engineer organisms for bioremediation and the potential risks of releasing them into the environment.

BEE 655(6550) Thermodynamics and Its Applications
Fall. 3 credits. Prerequisite: MATH 293 or equivalent; for undergraduates, permission of instructor. Letter grades only. Offered alternate years. J.-Y. Parlange.
Thermodynamics and its applications to problems in engineering and agriculture. Topics include basic concepts (equilibrium, entropy, processes, systems, potentials, stability, phase transitions) and applications (soil and water processes, dilute solutions, electromagnetism, surface phenomena, heat and mass transport, and structure of organizations).

[BEE 659(6590) Biosensors and Bioanalytical Techniques
Fall. 3 credits. Prerequisites: biochemistry course and permission of instructor. Letter grades only. Next offered 2008–2009. A. J. Baeumner.
For description, see BEE 459.]

[BEE 671(6710) Analysis of the Flow of Water and Chemicals in Soils
Fall. 3 credits. Prerequisites: four calculus courses and fluid mechanics course; for undergraduates, permission of instructor. Letter grades only. Offered alternate years; next offered 2008–2009. J.-Y. Parlange.
Encompasses a full range from simple to complex methods to describe the chemical and water flows on the surface, in the vadose zone, and through the aquifer. Discusses current analytical, semi-analytical, and computer-based techniques. Analyzes both homogeneous and heterogeneous soils.]

[BEE 672(6720) Drainage
Spring. 4 credits. Prerequisites: BEE 471 or BEE 473. Letter grades only. Offered alternate years; next offered 2008–2009. T. S. Steenhuis and L. D. Geohring.
Discusses the theory of water and solute flow in aquifers, hill slopes, and the vadose zone as it relates to artificial drainage. Critically reviews drainage design as it relates to agricultural land, landfills, and land application sites. Examines the importance of preferential flow and matrix flow on water quality of drainage waters. Laboratories provide hands-on experience with measuring soil parameters and for actual drainage design.]

BEE 674(6740) Ecohydrology
Spring. 3 credits. Prerequisite: ecology or hydrology course. Offered alternate years. Letter grades only. M. T. Walter.
The objective of this course is to investigate novel topics that involve the interactions between physical hydrological processes and ecosystem processes, including the impacts of human activities on the ecohydrological system. The course is designed to encourage teams of students from historically disparate disciplines to collaboratively combine their unique skills and insights to answer multidisciplinary ecohydrological questions. This course will consider a broad range scales from a stomate and a soil pore to a forest, watershed, and region, with emphasis placed on those scales and systems most appropriate to student interests. Through course work we will clarify the current understanding of various topics, identify knowledge gaps, develop hypotheses, and test them quantitatively by creating models and analyzing available data. The goal of this course is to identify the basic principles of ecohydrology and become familiar and comfortable with a range of quantitative tools and approaches for answering ecohydrological questions.

BEE 687(6870) The Science and Engineering Challenges to the Development of Sustainable Bio-Based Industries
Fall. 1 credit. Prerequisite: graduate standing. S-U grades only. L. P. Walker.
Environmentally sustainable alternatives for our energy and chemical needs are critical. This seminar series explores challenges facing the development of industries that use biologically derived materials to produce useful chemicals and energy for society. Topics include natural products from biological systems, conversion of biomass to fuel and other commodities, and the use of biological systems for environmental bioremediation.

BEE 694(6940) Graduate Special Topics in Biological and Environmental Engineering
Fall or spring. 4 credits max. S-U or letter grades. BEE graduate faculty.
The department teaches "trial" courses under this number. Offerings vary by semester, and are advertised by the department. Courses offered under this number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number. Each 694 has a unique course ID number.

BEE 697(6970) Graduate Individual Study in Biological and Environmental Engineering
Fall or spring. 1–6 credits. Prerequisite: permission of instructor. S-U or letter grades. BEE graduate faculty.
Topics are arranged by the staff at the beginning of the semester.

BEE 700(7010) BEE Seminar Series
Spring. 1 credit. S-U or letter grades. J. C. March and M. T. Walter.
Presentation and discussion of research and special developments pertinent to biological and environmental engineering and related fields.

BEE 740(6430) Veterinary Perspectives on Pathogen Control in Animal Manure (also VTMED/BIOMI 740[6430])
Spring, March 24–May 16. 2 credits. Prerequisite: graduate standing or permission of instructor. D. D. Bowman.
In-depth look at the management of pathogens in animal manures. Reviews the pathogens involved, the role of governing agencies, the survival of pathogens in the field, and methods of pathogen destruction. Discusses commercial methods of manure processing for the control of these pathogens for the protection of other animals and the human population. Concludes with class discussions with major stakeholders representing the dairy, beef, pork, and poultry industries and their understanding of the problem as it relates to veterinary students.

BEE 750(7000) Orientation to Graduate Study
Fall, first seven weeks. 1 credit. Prerequisite: new graduate students in BEE. S-U grades only. D. J. Aneshansley.
Introduction to BEE research policy, programs, methodology, resources, and degree candidates' responsibilities and opportunities.

BEE 754(7540) Water and Culture in the Mediterranean: A Crisis (also D SOC 694[6940])
Spring. 3 credits. Prerequisite: graduate standing or permission of instructors. S-U or letter grades. T. S. Steenhuis, G. Holst-Warhaft, et al.
The course addresses the crisis of water in the Mediterranean region, through case studies situated in watershed basins, especially those of the Nile and Litany Rivers. It focuses on attitudes, conflicts, and relationships of local people toward water, expressed in culture, sanitation, environmental laws, and agricultural practices.

BEE 760(7600) Nucleic Acid Engineering (also BME 760[7600])
Spring. 2 credits. Prerequisite: graduate standing; seniors by permission of instructor. S-U or letter grades. D. Luo.
Nucleic acid engineering focuses on manipulating nucleic acid molecules in a true engineering sense as well as in the "genetic engineering" sense by treating nucleic acids (including DNA, RNA, PNA, and TNA) as both genetic and generic materials. Both biomedical and nonbiomedical applications of nucleic acid engineering, including tool kits for nucleic acid engineering and current examples of DNA-based engineering, DNA nanotechnology, and DNA-based medicine are introduced. A design project and formal project presentation are required.

BEE 771(7710) Soil and Water Engineering Seminar
Fall and spring. 1 credit. Prerequisite: graduate standing or permission of instructor. S-U grades only. T. S. Steenhuis, J.-Y. Parlange, M. F. Walter, and M. T. Walter.
Study and discussion of research or design procedures related to selected topics in irrigation, drainage, erosion control, hydrology, and water quality.

BEE 787(7870) Industrial Ecology of Agriculturally Based Bioindustries
Spring. 3 credits. Prerequisites: graduate standing; one year of calculus, some knowledge of MATLAB, BEE 687. Letter grades only. Offered alternate years. L. P. Walker.
This course is designed to bring students from the life sciences and engineering together in teams to model and simulate sustainable agriculturally based bioindustries like those currently being used to produce bioenergy and biodegradable polymers. It is a system modeling and analysis course focused on interconnecting discrete physical, chemical, and biological processes to create novel industrial ecologies that are sustainable. An input/output modeling methodology is employed to develop and manipulate the structure of complex agriculturally based bioindustries and to generate the material, energy, and monetary flows. Special emphasis is placed on designing and analyzing webs of connected processes such that waste products from one process can be used as a raw material for another process. Students will use linear algebra and state space tools in the MATLAB toolbox to simulate static and dynamic behavior of these complex webs of connected processes and to conduct life cycle analysis of these complex webs.

[BEE 788(7880) Biomass Conversion of Energy and Chemicals
Spring. 3 credits. Prerequisite: one year of college calculus and chemistry; minimum of one course in thermodynamics and computer programming. Letter grades only. Offered alternate years; next offered 2008–2009. L. P. Walker.
Biological and physical conversion of biomass to bioenergy and bioproducts. Biological and engineering concepts associated with microbial and enzymatic conversion of biomass to useful products, physical and chemical concepts associated with the pretreatment of biomass and the separation of key biomolecules. Uses mass and energy balances and mathematical models (with MATLAB) to simulate process behavior.]

BEE 800(8900) Master's-Level Thesis Research
Fall and spring. 1–15 credits. Prerequisite: permission of advisor. S-U grades only. BEE graduate faculty. Variable credit for M.S. research.

BEE 900(9900) Doctoral-Level Thesis Research
Fall and spring. 1–15 credits. Prerequisite: permission of advisor. S-U grades only. BEE graduate faculty. Variable credit for Ph.D. research.

BIOLOGICAL SCIENCES

The program of study in biology is coordinated by the Office of Undergraduate Biology. For course descriptions, see the separate section "Biological Sciences."

BIOLOGY & SOCIETY

The undergraduate major field of study in biology & society is offered through the Department of Science and Technology Studies. For a full description of courses that fulfill field requirements, see "Biology & Society" under the College of Arts and Sciences.

BIOMETRY AND STATISTICS

M. Wells, chair (1190 Comstock Hall, 255-5488, -4388), J. Booth, C. Bustamante, G. Hooker, J. Mezey, S. J. Schwager, A. C. Siepel, R. Strawderman, S. Williamson

The Department of Biological Statistics and Computational Biology in Statistical Science offers the following courses in Biometry and Statistics. Students must register under Course Listings: College of Agriculture and Life Sciences—Biometry and Statistics.

BTRY 301(3010) Biological Statistics I (also NTRES 313[3130], STBTRY 301[3010])
Fall and summer. 4 credits.
Develops and applies statistical methods to problems encountered in the biological and environmental sciences. Methods include data visualization, population parameter estimation, sampling, bootstrap resampling, hypothesis testing, the Normal and other probability distributions, and an introduction to modeling. Carries out applied analysis in a statistical computing environment.

BTRY 302(3020) Biological Statistics II (also NTRES 413[4130], STBTRY 302[3020])
Spring. 4 credits. Prerequisite: BTRY 301 or 601.
Applies linear statistical methods to quantitative problems addressed in biological and environmental research. Methods include linear regression, inference, model assumption evaluation, the likelihood approach, matrix formulation, generalized linear models, single factor and multifactor analysis of variance (ANOVA), and a brief foray into nonlinear modeling. Carries out applied analysis in a statistical computing environment.

BTRY 310(3100) Statistical Sampling (also ILRST 310[3100], STBTRY 310[3100])
Fall. 3 credits. Prerequisites: two semesters of statistics.
Applied methodology and theory of statistical sampling, with particular emphasis on sampling methods, sample design, cost, estimation of population quantities, and error estimation. Assessment of nonsampling errors. Discussion of application to social and biological sciences and business. Includes an applied project.

BTRY 407(4070) Principles of Probability and Statistics (also STBTRY 407[4070])
Fall. 4 credits. Cannot be taken for credit after completion of BTRY 408/409 or MATH 471/472 sequence. Prerequisites: one year of calculus. Course is prerequisite for upper-division statistical genomics courses. Recommended: some knowledge of multivariate calculus and statistics.
A one-semester version of the BTRY 408/409 sequence. Topics include: combinatorial probability, conditional probability and independence, random variables (and their moments), standard distributions (multinomial, Poisson, normal, gamma, beta, etc.) and their properties. The second half of the course focuses on parametric inference using maximum likelihood and Bayesian approaches. Computational methods are emphasized using the R programming language. The course is a prerequisite for upper division statistical genomics courses. Cannot be taken for credit after completion of BTRY 408/409 or MATH 471/472 sequence.

BTRY 408(4080) Theory of Probability (also STBTRY 408[4080])
Fall. 4 credits. Prerequisites: MATH 111, 112, at least concurrent enrollment in 213 or 222 or equivalents. Recommended: at least one introductory course in statistical methods.
Introduction to probability theory: axiomatic foundations; combinatorics and equally likely events; conditional probability and independence; discrete and continuous random variables, their distributions and moments; generating functions; transformations; extensions to problems involving two or more random variables; random samples. Can serve as either one-semester introduction or a foundation for a course in statistical theory.

BTRY 409(4090) Theory of Statistics (also STBTRY 409[4090])
Spring. 4 credits. Prerequisites: BTRY 408 or equivalent and at least one introductory statistics course.
Introduction to classical theory of parametric statistical inference that builds on the material covered in BTRY 408. Topics include sampling distributions, principles of data reduction, likelihood, parameter estimation, hypothesis testing, interval estimation, and basic asymptotic theory.

BTRY 410(4100) Multivariate Analysis (also ILRST 410[4100], STBTRY 410[4100])
Spring. 4 credits. Prerequisites: BTRY 301, some knowledge of matrix algebra. S-U or letter grades.
Application of classical multivariate methods to data from a variety of fields using a statistical software package. Topics include the multivariate normal distribution, multivariate regression and MANOVA; principal components and factor analysis; canonical correlation; discriminant analysis and clustering.

[BTRY 421(4210) Matrix Computation
Fall. 4 credits. Prerequisite: calculus course. Next offered 2008–2009.
Introductory course in matrix computations that reviews linear algebra (vector spaces, linear independence) and emphasizes a matrix approach to solving systems (LU-factorization, QR-decomposition, SVD, Schur complements) and the role of the condition number of a matrix. Discusses positive definite matrices, eigenvalues, and their applications in mathematical modeling and statistics.]

[BTRY 482(4820) Statistical Genomics (also STBTRY 482[4820])
Fall. 4 credits. Prerequisites: MATH 111. Highly recommended: at least one previous course in statistical methods and one in biology. Next offered 2008–2009.
A course on the statistical analysis of genetic, molecular, and genomic data. The first module of the course presents a thorough treatment of important probability distributions and the concepts of likelihood and Bayesian inference. We then focus on how statistical models are developed for linkage analysis, basic Quantitative Trait Locus mapping, analysis of pedigrees,

molecular population genetics and genomics, and phylogenetic inference. Meets concurrently with BTRY 682.]

BTRY 483(4830) Quantitative Genomics and Genetics (also STBTRY 483[4830])
Spring. 4 credits. Prerequisites: introductory statistics or equivalent. S-U or letter grades.
A rigorous treatment of analysis techniques used to understand complex genetic systems. This course will cover both the fundamentals and advances in statistical methodology used to analyze disease, agriculturally relevant, and evolutionarily important phenotypes. Topics will include mapping quantitative trait loci (QTLs), application of microarray and related genomic data to gene mapping, and evolutionary quantitative genetics. Analysis techniques will include association mapping, interval mapping, and analysis of pedigrees for both single and multiple QTL models. Application of classical inference and Bayesian analysis approaches will be covered and there will be an emphasis on computational methods. Meets concurrently with BTRY 683.

BTRY 484(4840) Computational Genomics (also STBTRY 484[4840])
Fall. 4 credits. Highly recommended: at least one previous course in statistical methods and at least one in algorithms.
A rigorous treatment of important computational principles and methods for the analysis of genomic data, emphasizing comparative and evolutionary genomics. Topics include sequence alignment, gene and motif finding, phylogeny reconstruction, and inference of gene regulatory networks. Covers both maximum likelihood and Bayesian principles, and both exact and approximate algorithms for inference. Draws heavily on general concepts from probabilistic graphical models. Meets concurrently with BTRY 684.

BTRY 494(4940) Undergraduate Special Topics in Biometry and Statistics (also STBTRY 494[4940])
Fall or spring. 1–3 credits. S-U or letter grades.
Course of lectures selected by the faculty. Because topics usually change from year to year, this course may be repeated for credit.

BTRY 495(4950) Statistical Consulting (also STBTRY 495[4950])
Fall and spring. 2–3 credits. Pre- or corequisites: BTRY 302 or 602 and 409 and permission of instructor. S-U or letter grades.
Participation in the Department of Biological Statistics and Computational Biology consulting service: faculty-supervised statistical consulting with researchers from other disciplines. Discussion sessions are held for joint consideration of literature and selected consultations encountered during previous weeks.

BTRY 496(4960) Statistical Consulting II (also STBTRY 496[4960])
Fall and spring. 1 credit. Prerequisites: BTRY 302 or 602, and 409 and 495. S-U grades only.
Participation in the newly formed Cornell Statistical Consulting Unit: Faculty-supervised statistical consulting with researchers from other disciplines. Discussion sessions for joint consideration of literature and selected consultations encountered during previous weeks.

BTRY 497(4970) Undergraduate Individual Study in Biometry and Statistics (also STBTRY 497[4970])
Fall and spring. 1–3 credits. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall).
Consists of individual tutorial study selected by the faculty. Because topics usually change from year to year, this course may be repeated for credit.

BTRY 498(4980) Undergraduate Supervised Teaching (also STBTRY 498[4980])
Fall and spring. 2 credits. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall).
Students assist in teaching a course appropriate to their previous training. Students meet with a discussion or laboratory section and regularly discuss objectives with the course instructor.

BTRY 499(4990) Undergraduate Research (also STBTRY 499[4990])
Fall or spring. 1–3 credits. Prerequisite: statistics and biometry undergraduates; permission of faculty member directing research. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall).

BTRY 601(6010) Statistical Methods I (also STBTRY 601[6010])
Fall and summer. 4 credits. Prerequisite: graduate standing or permission of instructor.
Develops and uses statistical methods to analyze data arising from a wide variety of applications. Topics include descriptive statistics, point and interval estimation, hypothesis testing, inference for a single population, comparisons between two populations, one- and two-way analysis of variance, comparisons among population means, analysis of categorical data, and correlation and regression analysis. Introduces interactive computing through statistical software. Emphasizes basic principles and criteria for selection of statistical techniques.

BTRY 602(6020) Statistical Methods II (also STBTRY 602[6020])
Spring. 4 credits. Prerequisite: graduate standing or permission of instructor; BTRY 601 or equivalent.
Continuation of BTRY 601. Emphasizes the use of multiple regression analysis, analysis of variance, and related techniques to analyze data in a variety of situations. Topics include an introduction to data collection techniques; least squares estimation; multiple regression; model selection techniques; detection of influential points, goodness-of-fit criteria; principles of experimental design; analysis of variance for a number of designs, including multi-way factorial, nested, and split plot designs; comparing two or more regression lines; and analysis of covariance. Emphasizes appropriate design of studies before data collection, and the appropriate application and interpretation of statistical techniques. Practical applications are implemented using a modern, widely available statistical package.

BTRY 603(6030) Statistical Methods III: Categorical Data (also ILR 411[4110], STBTRY 603[6030])
Spring. 3 credits. Prerequisite: BTRY 601 and 602 or permission of instructor. Offered alternate years.
Categorical data analysis, including logistic regression, log-linear models, stratified tables, matched pairs analysis, polytomous response and ordinal data. Applications in biomedical and social sciences.

BTRY 604(6040) Statistical Methods IV: Applied Design (also STBTRY 604[6040])
Spring. 4 credits. Prerequisites: BTRY 601 and 602 or permission of instructor. Offered alternate years.
Applications of experimental design including such advanced designs as split plots, incomplete blocks, fractional factorials. Stresses use of the computer for both design and analysis, with emphasis on solutions of real data problems.

BTRY 607(600) Principles of Probability and Statistics (also STBTRY 607[6070])
Fall. 4 credits. Prerequsite: one year of calculus. Recommended: some knowledge of multivariate statistics.
For description, see BTRY 407.

BTRY 652(6520) Computationally Intensive Statistical Inference (also STBTRY 652[6520])
Spring. 4 credits. Prerequisite: OR&IE 670 and at least one course in probability. S-U or letter grades. Offered alternate years.
Modern applications in statistics often require intensive computation not handled by "off-the-shelf" software. This course covers topics in statistical computing, including numerical optimization and finding zeros (likelihood and related techniques including generalized estimating equations and robust estimation), kernel density estimation, resampling methods (randomization and bootstrap tests and confidence intervals), and statistical simulation (random number generation, heuristic search methods, Bayesian estimation, and Monte Carlo Markov Chain methods for tests and interval estimation). Programming is done in MATLAB. Focuses on the use of numerical analysis methods for solving problems in statistical inference and estimation.

[BTRY 682(6820) Statistical Genomics (also STBTRY 682[6820])
Fall. 4 credits. Prerequisite: MATH 111. Highly recommended: at least one previous course in statistical methods and one in biology. Next offered 2008–2009.
A course on the statistical analysis of genetic, molecular, and genomic data. The first module of the course presents a thorough treatment of important probability distributions and the concepts of likelihood and Bayesian inference. We then focus on how statistical models are developed for linkage analysis, basic Quantitative Trait Locus mapping, analysis of pedigrees, molecular population genetics and genomics, and phylogenetic inference. Meets concurrently with BTRY 482.]

BTRY 683(6830) Quantitative Genomics and Genetics (also STBTRY 683[6830])
Spring. 4 credits. Prerequisites: introductory statistics course or equivalent. S-U or letter grades.
A rigorous treatment of analysis techniques used to understand complex genetic systems. This course will cover both the fundamentals and advances in statistical methodology used to analyze disease, agriculturally relevant, and evolutionarily important phenotypes. Topics will include mapping quantitative trait loci (QTLs), application of microarray and related genomic data to gene mapping, and evolutionary quantitative genetics. Analysis techniques will include association mapping, interval mapping, and analysis of pedigrees for both single and multiple QTL models. Application of classic inference and Bayesian analysis approaches will be covered and there will be an emphasis on computational methods. Meets concurrently with BTRY 483.

BTRY 684(6840) Computational Genomics (also STBTRY 684[6840])
Fall. 4 credits. Highly recommended: at least one previous course in statistical methods and at least one in algorithms.
A rigorous treatment of important computational principles and methods for the analysis of genomic data, emphasizing comparative and evolutionary genomics. Topics include sequence alignment, gene and motif finding, phylogeny reconstruction, and inference of gene regulatory networks. Covers both maximum likelihood and Bayesian principles, and both exact and approximate algorithms for inference. Draws heavily on general concepts from probabilistic graphical models. Meets concurrently with BTRY 484.

BTRY 689(6890) Topics in Population Genetics and Genomics (also STBTRY 689[6890])
Fall. 1 credit; may be repeated for credit. Prerequisite: BTRY 682 or permission of instructor.
This course is a graduate seminar on current topics in population genetic data analysis. Topics this semester may include: detecting signatures of natural selection, estimating demographic parameters, and recombination rate variation from whole-genome data; statistical methods for association mapping; efficient methods for disease gene mapping; use of comparative genomic data for population genetic inference. Readings will be chosen primarily from current literature.

BTRY 694(6940) Graduate Special Topics in Biometry and Statistics (also STBTRY 694[6920])
Fall or spring. 1–3 credits. S-U or letter grades.
Course of lectures selected by the faculty. Because topics usually change from year to year, this course may be repeated for credit.

BTRY 697(6970) Individual Graduate Study in Biometry and Statistics (also STBTRY 697[6970])
Fall, spring, or summer. 1–3 credits. S-U or letter grades.
Individual tutorial study selected by the faculty. Because topics usually change from year to year, this course may be repeated for credit.

[BTRY 717(7170) Theory of Linear Models (also STBTRY 717[7170])
Fall. 3 credits. Prerequisites: BTRY 409, 421, and 602 or equivalents. S-U or letter grades. Next offered 2008–2009.
Properties of the multivariate normal distribution. Distribution theory for quadratic forms. Properties of least squares and maximum likelihood estimates. Methods for fixed effect models of less than full rank. Analysis of balanced and unbalanced mixed effects models. Restricted maximum likelihood estimation. Some use of software packages and illustrative examples.]

BTRY 718(7180) Generalized Linear Models (also STBTRY 718[7180])
Fall. 3 credits. Prerequisites: primarily for Ph.D. students in statistics; BTRY 602, BTRY 409, or equivalent. S-U or letter grades.
A theoretical development of generalized linear models and related topics including generalized estimating equations, and generalized linear mixed models.

BTRY 720(7200) Topics in Computational Genomics (also STBTRY 720[7200])
Spring. 1 credit. Prerequisite: BTRY 484/684 or permission of instructor.
Weekly seminar series on recent advances in computational genomics. A selection of the latest papers in the field will be read and discussed. Methods will be stressed, but biological results and their significance will also be addressed.

BTRY 726(7260) Problems and Perspectives in Computational Molecular Biology (also PL BR 726[7260], CS 726[7590])
Fall and spring. 1 credit. Prerequisite: permission of instructor. S-U grades only.
Weekly seminar series discussing timely topics of computational molecular biology. Addresses methodological approaches to sequence annotation, protein structure and function relationships, and evolutionary relationships across species. Discusses statistical and deterministic computational approaches are covered and specific and detailed biological examples. Discusses topics of interest discussed in relation to papers prepared by teams of students and/or faculty members. Students/faculty members from biology backgrounds are paired with students from math, computer science, and statistics for paper preparation. Students summarize the salient questions addressed by the paper, the research methods used, and the results obtained. At the end of the presentation, questions should be listed on an overhead slide to initiate discussion in the group.

[BTRY 727(7270) Advanced Survival Analysis (also STBTRY 727[7270])
Fall. 3 credits. Prerequisites: at least one graduate-level course in probability, mathematical statistics, and regression modeling. S-U or letter grades. Next offered 2008–2009
This course focuses on the rigorous development of nonparametric, semiparametric, and parametric modeling and statistical inference procedures appropriate for analyzing right censored data arising in single sample, k-sample, and regression problems. Tools to be discussed in detail include the Nelson-Aalen and Kaplan-Meier estimators, the logrank test, and the Cox proportional hazards and accelerated failure time regression models. Counting process notation and elementary martingale theory are used to facilitate the development of the large sample theory required for statistical estimation and testing procedures.]

BTRY 795(7950) Statistical Consulting (also STBTRY 795[7950])
Fall and spring. 2–3 credits. Pre- or corequisites: BTRY 602 and 409 and permission of instructor. S-U or letter grades.
Participation in the Department of Biological Statistics and Computational Biology consulting service: faculty-supervised statistical consulting with researchers from other disciplines. Discussion sessions are held for joint consideration of literature and selected consultations encountered during previous weeks.

BTRY 798(7980) Graduate Supervised Teaching (also STBTRY 798[7980])
Fall and spring. 2–4 credits. Prerequisites: permission of instructor and chair of special committee plus at least two advanced courses in statistics and biometry. S-U grades only.
Students assist in teaching a course appropriate to their previous training. Students meet with a discussion section, prepare course materials, and assist in grading. Credit hours are determined in consultation with the instructor, depending on the level of teaching and the quality of work expected.

BTRY 800(8900) Master's-Level Thesis Research
Fall or spring. Credit TBA. Prerequisite: M.S. candidates; permission of graduate field member concerned. S-U grades only.
Research at the M.S. level.

BTRY 900(9900) Graduate-Level Dissertation Research
Fall or spring. Credit TBA. Prerequisite: Ph.D. candidates; permission of graduate field member concerned. S-U grades only.
Research at the Ph.D. level.

BTRY 901(9910) Doctoral-Level Dissertation Research
Fall or spring. Credit TBA. S-U grades only.

COMMUNICATION

G. K. Gay, chair; K. L. Berggren, J. P. Birnholtz, S. E. Byrne, R. D. Colle, B. O. Earle, T. L. Gillespie, D. A. Grossman, J. T. Hancock, L. C. Levitan, B. V. Lewenstein, K. A. McComas, P. L. McLeod, S. M. Nelson, R. E. Ostman, T. M. Russo, C. W. Scherer, M. A. Shapiro, L. P. Van Buskirk, Y. C. Yuan

COMM 101(1010) Cases in Communication (SBA)
Fall. 3 credits. B. Lewenstein.
Through analysis of cases, this course introduces students to key principles and theories in the study of human communication. Cases cover personal situations, entertainment, national crises, business situations, new technologies, and other contexts. The goal is to understand the links between these daily activities, "mid-range" theories of human behavior, and broad social concepts of modernity and post-modernity.

COMM 130(1300) Visual Communication (SBA)
Spring. 3 credits. C. Scherer.
Introduction to visual communication theory. Examines how visuals influence our attention, perspectives, and understanding. Uses examples of visuals drawn from advertising, TV news, documentaries, entertainment movies, print, and interactive media develop a theoretical framework for becoming more visually aware and for thinking more critically about how visuals influence us.

COMM 131(1310) Writing about Communication
Spring. 3 credits. Corequisite: COMM 130. L. Van Buskirk and staff.
Students develop skill in various writing styles and genres. This course explores communication practices and theories as they are observed and studied in personal and professional contexts. Assignments polish students' ability to gather information, analyze information, integrate ideas about communication, and express those ideas clearly and cogently. Several assignments focus on visual communication theories explored in COMM 130 as well as ideas from COMM 101.

COMM 201(2010) Oral Communication (D)
Fall, spring, or summer. 3 credits. Limited to 20 students per sec (fall and spring) or 15 students per sec (summer). Priority given to juniors and seniors, then sophomores. Fluency in spoken English assumed. Sections meet beginning first day of instruction; may precede lecture. Students absent twice during first week of class are dropped from course roster. Enrolled students must drop by end of second week to allow wait-listed students to add course. K. Berggren, T. Russo, and staff.
Through theory and practice, students develop self-confidence and competence in researching, organizing, and presenting material to audiences. Students give four graded speeches, write short papers, perform speaker evaluations, and engage in other speech-related activities.

COMM 203(2030) Argumentation and Debate (D)
Fall, spring, and summer. 3 credits. S. Nelson.
Students learn the principles of argumentation and debate. Topics emphasize Internet database research, synthesis of collected data, policy analysis of evidentiary quality, refutation of counter claims, identification of logical fallacies, risk evaluation, framing of issues, and coherent storytelling. Prepares students to work with a great range of opinion and evidence. Emphasizes different viewpoints, including those of different cultures. Assumptions are interrogated.

COMM 220(2300) Contemporary Mass Communication (SBA) (D)
Fall or summer. Staff.
The processes and effects of mass communication systems. Topics include the evolution of communication media, current knowledge about mediated communication, and the role of communication in contemporary social issues.

COMM 245(2450) Psychology of Social Computing (also INFO 245[2450]) (SBA)
Fall. 3 credits. J. Hancock and staff.
Course focuses on understanding online communication through principles of cognitive and social psychology, and aspects of the Internet that defy traditional psychological understandings. Topics include impression formation and management, deception and trust, group dynamics, social support, "Internet addiction," online pornography, and organizational impacts of new communication technology.

COMM 263(2630) Organizational Writing
Fall, spring, or summer. 3 credits. Limited to 25 students per sec. Prerequisite: junior, senior, or graduate standing; college-level writing course. L. Van Buskirk and staff.
Students write from the point of view of various organizations, including businesses, government agencies, and nonprofit organizations. This course emphasizes appropriate representation of the writer's organization, audience analysis, and clear and effective written presentation of detailed content. Assignments include text for web sites, reports, proposals, memoranda, letters, and e-mail.

COMM 272(2720) Principles of Public Relations and Advertising
Summer. 3 credits. Not open to freshmen. Staff.
Survey of the fields of public relations and advertising. Describes organizations, jobs, and functions in the industry. Covers the roles of public relations and advertising in society, the economic system, and organizations; psychological and sociological principles as bases for appeals; strategies for media selection and message execution. Introduction to research and regulation.

COMM 276(2760) Cases in Communication and Social Influence (SBA)
Spring. 3 credits. Prerequisite: COMM 101. P. McLeod.
Social influence is one of the most basic and important functions of communication. This course introduces communication majors to the focus area of Communication and Social Inference (CSI). Through case studies, exercises and field projects the course will address issues ranging from influence between individuals to influence at national and international levels.

COMM 282(2820) Research Methods in Communication Studies (SBA)
Fall. 3 credits. Pre- or corequisite: sophomore standing. C. Yuan.
The course covers social scientific methods to solve communication research problems empirically. Topics include basic principles of social scientific research, random sampling, questionnaire design, experimental research design, focus group techniques, content analysis, and basic descriptive and inferential statistics. Students will also learn basic data manipulation, presentation and analysis techniques using SPSS and EXCEL.

COMM 284(2840) Sex, Gender, and Communication (also FGSS 284[2840]) (D) (SBA)
Fall. 3 credits. Not open to freshmen. L. Van Buskirk.
Explores the personal, career, social, and economic implications of male and female gender categories. Topics include theories of male and female gender construction, social structures, personal relationships, and gender concerns in the workplace.

COMM 285(2850) Communication in Life Sciences (also S&TS 285[2851]) (SBA)
Spring. 3 credits. B. Lewenstein.
Environmental problems, public health issues, scientific research—in each of these areas, communication plays a fundamental role. From the mass media to individual conversations, from technical journals to textbooks, from lab notes to the web, communication helps define scientifically based social issues and research findings. This course examines the institutional and intellectual contexts, processes, and practical constraints on communication in the life sciences.

COMM 301(3010) Business and Professional Presentation
Fall and spring. 3 credits. Prerequisite: COMM 201; second-semester sophomore, junior, or senior standing. Staff.
The study and practice of written and oral communication skills used in formal and informal organizations. These skills include interviews; informative, persuasive, and special-occasion speeches; reports; discussions; and PowerPoint presentations. Students study and practice the organizational, analytical, and presentational skills needed in contexts suited to their own business and professional career goals.

[COMM 303(3030) Speech and Debate Practicum
Fall and spring. 2 credits. Prerequisite: Program in Speech and Debate members; permission of instructor; completion of one year in program. Next offered 2008–2009. S Nelson.
Students learn how to prepare for CEDA (Cross Examination Debate Association) debate, Lincoln-Douglas debate, or individual speaking events. The class is divided into four groups according to level of experience; therefore, it may be repeated to a maximum of 8 credits.]

COMM 310(3100) Communication and Decision Making in Groups (SBA)
Spring. 3 credits. Prerequisite: junior or senior standing; priority given to COMM majors. P. McLeod.
This course will provide students with a greater understanding of information sharing, persuasion, and decision development in small work groups. Through practical exercises, class discussions and lectures, students will learn firsthand how tools such as decision structuring process can affect group performance. The course will be taught in an interactive hands-on format that emphasizes application of tested theory.

COMM 320(3200) New Media and Society (also INFO 320[3200]) (CA)
Spring. 3 credits. T. Gillespie.
This course builds on mass communication research and the study of culture and technology to investigate the social, political, and technological dynamics of contemporary media. We investigate how mass media frames our experience of the world and shapes our political involvement in it, and at

how mass media intersects with our sense of identity and role in culture.

COMM 345(3450) Human–Computer Interaction Design (also INFO 345[3450]) (SBA)
Spring. 3 credits. G. Gay and staff.
Gives students insight into the design of computer interfaces and software from the user's point of view. Students come to understand how hardware and software design influence the interaction between people and computers. Using assigned readings, demonstrations, and projects, students examine issues and trade-offs in interaction design and invent and evaluate alternative solutions.

COMM 349(3490) Media Technologies (also S&TS 349[3491]) (CA)
Spring. 3 credits. Offered odd-numbered years. T. Gillespie.
Our efforts to communicate, share culture, and drive social agendas depend on the tools we've developed. However, our commonplace notions of communication and media regularly overlook the role of the material technologies that are so crucial to them. This course considers the technologies of media (including printing, photography, film, telegraph, telephone, radio, television, and computer networks) as an opportunity to think about the intersection of technology, communication, and its social context.

COMM 352(3520) Science Writing for the Mass Media (also S&TS 352[3521])
Fall and spring. 3 credits. Limited to 24 students. Not open to freshmen. Prerequisite: college-level writing course. B. Lewenstein and staff.
How to write about science, technology, and medicine for the mass media. Discussion topics include accuracy, simplicity, comprehensiveness, risk communication, and the history and social structure of science. Writing assignments focus on writing news and feature stories for newspapers and magazines, with excursions into web sites, blogs, and other media.

COMM 353(3530) Science Writing Practicum
Spring. 1 credit. Prerequisite: COMM 260, COMM/S&TS 352, ENGRC 350, or permission of instructor. B. Lewenstein.
Students cover the annual meeting of the American Association for the Advancement of Science, held in February each year. Before the meeting, students review science writing techniques and issues. At the meeting, students meet with science writers and attend press conferences and scientific sessions. Students write at least two stories. Students are responsible for all costs of travel, lodging, and meals.

COMM 376(3760) Planning Communication Campaigns (SBA)
Fall. 3 credits. Pre- or corequisites: COMM 282 or equivalent social research course and one semester of introductory statistics. K. McComas.
Provides a theoretical and practical overview of the audiences, messages, and evaluation of communication campaigns. Includes principles of planning and evaluation relevant to several kinds of campaigns. Topics include discussion of campaign goals, objectives, strategies, and tactics; research design and implementation; audience segmentation; message construction; and techniques of evaluation. Considers common methods of data collection (e.g., focus groups, experiments, surveys) and analysis of campaign-related data sources.

COMM 398(3980) Issues in Teaching Communication (KCM)
Fall and spring. 1 credit. Pre- or corequisite: junior or senior standing; present or past undergraduate teaching assistant for COMM course. K. Berggren.
Seminar bringing together novice educators to discuss ideas, experiences, and practice. Integration of theory into actual education efforts is challenging for professional educators. Novice teachers are not aware of their common experiences, much less of a theoretical component to education. In discussions of actual teaching experiences, literature reviews, research reports, textbook chapters, curriculum, and evaluation tools, students examine new ideas and practices. The primary goal of the seminar is to enrich and deepen the novice teaching experience.

COMM 405(4050) Community Service Practicum
Fall and spring. 1 credit; may be repeated once for credit. Meets one hour weekly. S. Nelson.
Students share their communication talents in structured experiences in which they design and implement a speech or debate project in local schools or the community.

COMM 410(4100) Organizational Communication: Theory and Practice (D) (CA)
Spring. 3 credits. Prerequisite: junior, senior, or graduate standing; COMM 101 or permission of instructor. C. Yuan.
Study of management communication processes in formal organizations. Applies relevant organizational behavior and communication principles in today's business environment; examines formal and informal communication networks.

COMM 420(4200) Public Opinion and Social Process (SBA)
Spring. 3 credits. Prerequisite: COMM 282. Offered even-numbered years. Staff.
The course provides a scientific and applied overview of the concept of "public opinion" and its implications for macrosocial processes. The concept's historical development in fields such as political science, social psychology, and communication science is reviewed, followed by a closer look at what is meant by "measuring" public opinion. For example, is public opinion measured by summing across individual opinions, or are there macro-level dynamics of public opinion that go beyond what individuals in a society think?

COMM 421(4210) Communication and the Environment (SBA)
Spring. 3 credits. Offered odd-numbered years. Staff.
Students investigate how values, attitudes, social structure, and communication affect public perceptions of environmental risk and public opinion about the environment. A primary focus is mass media's impact on public perceptions of the environment, how the media portray the environment, and discussion of the implications of public consumption of environmental content.

[COMM 422(4220) Psychology of Television (and Beyond) (SBA)
Fall. 3 credits. Prerequisites: introductory psychology or HD 120 or COMM 101 or 220. Next offered 2008–2009. M. Shapiro.
Survey of knowledge about how people mentally process television and other audiovisual communication technologies—including movies, video games, virtual reality, and the Internet. Topics include why people watch, what happens mentally when they watch, how people understand and mentally process media, and how media psychologically influence beliefs, attitudes, thinking, and emotion.]

COMM 428(4280) Communication Law
Spring. 3 credits. Prerequisite: junior, senior, or graduate standing or permission of instructor. D. Grossman.
This course deals with the law governing communication media. Topics include First Amendment concepts, restraints on newsgathering and dissemination, libel, invasion of privacy, copyright protection, regulation of broadcast and nonbroadcast electronic media, advertising law, and current legal issues unique to online communication.

COMM 429(4290) Copyright in the Digital Age (also INFO 429[4290]) (CA)
Fall. 3 credits. Offered odd-numbered years. T. Gillespie.
This course looks at recent legal and cultural battles about digital copyright, to investigate how participation in a digital world is structured: who speaks, what they can say, who hears, and with what consequences. We use these cases to look at the collision of authorship and the market, technology and law, individual and institution, culture and power.

COMM 440(4400) Advanced Human-Computer Interaction Design (also INFO 440[4400]) (SBA)
Fall. 3 credits. Prerequisite: COMM/INFO 245 or permission of instructor. G. Gay and staff.
Focuses on the design of computer interfaces and software from the user's point of view. The goal is to teach user interface designs that "serve human needs" while building feelings of competence, confidence, and satisfaction. Topics include formal models of people and interactions, collaborative design issues, psychological and philosophical design considerations, and cultural and social issues.

[COMM 445(4450) Seminar in Computer-Mediated Communication (also INFO 445[4450]) (SBA)
Fall. 3 credits. Prerequisite: COMM/INFO 245. Next offered 2009–2010. J. Hancock and staff.
Focuses on reading and evaluating the theories and research methodologies used to investigate communication via computer systems. Assignments include student collaborations using electronic conferencing and other advanced communication technologies, as well as reflections on and evaluations of these collaborations in light of current theories and research findings. Topics include virtual teams, videoconferencing, and others as they emerge.]

COMM 450(4500) Language and Technology (also INFO 450[4500]) (SBA)
Spring. 3 credits. J. Hancock and staff.

Examines how new communication technologies affect the way we produce and understand language and modify interaction with one another. Focuses on the collaborative nature of language use and how Internet technologies affect the joint activities of speakers and listeners during the construction of meaning in conversation.

COMM 456(4560) Community Involvement in Environmental Decisions (SBA)
Spring. 3 credits. Prerequisite: junior or senior standing or permission of instructor. Offered odd-numbered years. K. McComas.
Community involvement is an essential part of environmental decision making, but it is also one of the most challenging aspects of the decision making process. Through selected readings and course activities, this class will examine both traditional and contemporary methods of community involvement. When evaluating the methods, the class will discuss how social structures work to define criteria for success.

COMM 466(4660) Public Communication of Science and Technology (also S&TS 466[4660]) (SBA)
Spring. 3 credits. Prerequisite: COMM 260, 285, or 352, ENGRC 350, or permission of instructor. Offered even-numbered years. B. Lewenstein.
Explores the structure, meanings, and implications of "public communication of science and technology" (PCST). Examines the contexts in which PCST occurs, looks at motivations and constraints of those involved in producing information about science for nonprofessional audiences, and analyzes the functions of PCST. Ties existing ideas about PCST to general communication research, and leads to developing new knowledge about PCST. Format is primarily seminar/discussion.

COMM 476(4760) Communication Fellows Program
Spring. 2 credits. Prerequisites: communication seniors selected based on goals and academic preparation; permission of instructor. Fee for three-day trip: $150. Staff.
Series of lectures, seminars, and guest speakers exploring the planning, evaluation, and policy-making process. Includes a three-day trip to a metropolitan area to visit corporate leaders, administrative agencies, and policymakers.

COMM 480(4800) Independent Honors Research in Social Science
Fall or spring. 1–6 credits. Prerequisite: undergraduate standing; requirements met for honors program. Staff.
Students who have successfully completed COMM 382 register for no more than 3 credits. Students who have not completed an advanced research methods course may register for up to 6 credit hours.

COMM 486(4860) Risk Communication (SBA)
Fall. 3 credits. C. Scherer.
Examination of theory and research related to the communication of scientific information about environmental, agricultural, food, health, and nutritional risks. Concentrates on social theories related to risk perception and behavior. Examines case studies involving pesticide residues, waste management, water quality, environmental hazards, and personal health behaviors. Emphasizes understanding, applying, and developing theories.

COMM 494(4940) Special Topics in Communication (D)
Fall, spring, or summer. 1–3 credits, variable. Prerequisite: permission of instructor. S-U or letter grades.
Study of topics in communication not otherwise provided by a department course and determined by the interest of the faculty and students.

COMM 496(4960) Communication Internship
Fall or spring. Work component and variable. 1 credit; may be repeated once for a total of 2 credits. Prerequisite: COMM major or minor (first-, second-, third-, or fourth-year) for 1 credit (minimum 60 hours). K. Berggren.
Students receive a structured, on-the-job learning experience under the supervision of communication professionals in cooperating organization. A minimum of 60 hours of on-the-job work is required; the number of work hours beyond 60 is left to the discretion of the intern and the supervising company. A final paper linking communication theory to practical work experience is required. All internships must be approved before the work experience segment by the internship coordinator.

COMM 497(4970) Individual Study in Communication
Fall or spring. 1–3 credits; may be repeated to 6 credits with different supervising faculty member. Prerequisite: 3.0 GPA. Students must register using independent study form (available in 140 Roberts Hall).
Individual study under faculty supervision. Work should concentrate on locating, assimilating, synthesizing, and reporting existing knowledge on a selected topic. Attempts to implement this knowledge in a practical application are desirable.

COMM 498(4980) Communication Teaching Experience
Fall or spring. 1–3 credits; may be repeated to 6 credits with different courses. Intended for undergraduates desiring classroom teaching experience. Prerequisite: junior or senior standing; 3.0 GPA (2.7 if teaching assistant for skills development course); permission of faculty member who supervises work and assigns grade. Students must register using independent study form (available in 140 Roberts Hall).
Periodic meetings with the instructor cover realization of course objectives, evaluation of teaching methods, and student feedback. In addition to aiding with the actual instruction, each student prepares a paper on some aspect of the course.

COMM 499(4990) Independent Research
Fall or spring. 1–3 credits; may be repeated to 6 credits. Prerequisites: senior standing; 3.0 GPA. Students must register using independent study form (available in 140 Roberts Hall).
Permits outstanding students to conduct laboratory or field research in communication under appropriate faculty supervision. The research should be scientific: systematic, controlled, empirical. Research goals should include description, prediction, explanation, or policy orientation and should generate new knowledge.

[COMM 610(6100) Seminar in Social Networks
Spring. 3 credits. Prerequisite: graduate standing. Next offered 2008–2009. C. Yuan.
Examination of the structures and processes of group, organizational, and social networks. Review of research literature in communication and social networks. Survey of network methods with an emphasis on quantitative analysis using relevant software. Application of graph theory, matrix algebra, and sociometry techniques. Analysis and social interpretation of extant network datasets.]

COMM 618(6180) Communication and Persuasion
Spring. 3 credits. Prerequisite: introductory research methods course and introductory psychology or social psychology course. Staff.
Focuses on theories of communication's influence on persuasion and attitude change. Familiarizes students with a variety of social-psychological theories of attitude change and persuasion. Also applies those theories to a variety of communication situations including mass communication, advertising, public relations/public information, and interpersonal communication.

COMM 621(6210) Advanced Communication and the Environment
Spring. 3 credits. Offered odd-numbered years. Staff.
Students investigate how values, attitudes, social structure, and communication affect public perceptions of environmental risk and public opinion about the environment. A primary focus is mass media's impact on public perceptions of the environment, how the media portray the environment, and discussion of the implications of public consumption of environmental content. Lectures concurrent with COMM 421; graduate students should enroll in COMM 621.

[COMM 622(6220) Advanced Psychology of Television (and Beyond)
Fall. 3 credits. Prerequisites: graduate standing and permission of instructor. Next offered 2008–2009. M. Shapiro.
Survey of knowledge about how people mentally process television and other audiovisual communication technologies—including movies, video games, virtual reality, and the Internet. Topics include why people watch, what happens mentally when they watch, how people understand and mentally process media, and how media psychologically influence beliefs, attitudes, thinking, and emotion.]

COMM 624(6240) Communication in the Developing Nations
Fall. 3 credits. Prerequisite: junior, senior, or graduate standing. R. D. Colle.
The role of communication in development programs, particularly in Third World nations. Emphasizes communication interventions in agriculture, health, nutrition, family planning, and community development, and especially methods for designing communication strategies for reaching low-income, rural people. Among the approaches considered

are extension, social marketing, and development support communication.

COMM 640(6400) Human–Computer Interaction Design (also INFO 640[6400])
Fall. 3 credits. Prerequisite: graduate standing or permission of instructor. G. Gay and staff.
Graduate-level readings and research supplementing COMM/INFO 440. Focuses on the design of computer interfaces and software from the user's point of view. The goal is to teach user interface designs that "serve human needs" while building feelings of competence, confidence, and satisfaction. Topics include formal models of people and interactions, collaborative design issues, psychological and philosophical design considerations, and cultural and social issues.

[COMM 645(6450) CMC Graduate Seminar (also INFO 645[6450])
Spring. 3 credits. Prerequisite: graduate standing or permission of instructor. Next offered 2008–2009. J. Hancock and staff.
Graduate-level readings and research supplementing COMM/INFO 445. Through close reading and research in communication and technology, and participation in projects using these technologies, students enhance experiential, theoretical, and critical understanding of contemporary computer-mediated communication systems and uses. Topics include virtual teams, videoconferencing, and others.]

COMM 650(6500) Language and Technology (also INFO 650[6500])
Spring. 3 credits. J. Hancock and staff.
Graduate-level readings and research supplementing COMM/INFO 450. Examines how new communication technologies affect the way we produce and understand language and modify interaction with one another. Focuses on the collaborative nature of language use and how Internet technologies affect the joint activities of speakers and listeners during the construction of meaning in conversation.

COMM 680(6800) Studies in Communication
Fall. 3 credits. Prerequisite: communication graduate students or permission of instructor. Staff.
Reviews classical and contemporary readings in communication, including key concepts and areas of investigation. Explores the scope of the field, the interrelationships of its various branches, and examines the role of theory in the research process.

COMM 681(6810) Advanced Communication Theory
Spring. 3 credits. Prerequisite: COMM 680 or graduate standing and permission of instructor. M. Shapiro.
Development of, and contemporary issues in, communication theory. Discusses the interaction between communication and society, social groupings, and mental processing.

COMM 682(6820) Methods of Communication Research
Fall. 3 credits. Recommended: familiarity with basic statistical concepts. P. McLeod.
Analyzes methods of communication research based on a social science foundation. Goals will be to understand processes and rationales for qualitative, textual, survey, and experimental methods and to experience each method through modest individual or group research projects. Critiques of selected contemporary communication studies.

[COMM 683(6830) Qualitative Research Methods in Communication]

[COMM 684(6840) Theories and Methods of Small Group Research
Fall. 3 credits. Next offered 2008–2009. P. McLeod.
The main objective of this course is to prepare doctoral students to conduct independent empirical research relevant to small groups within organizations. We will examine theoretical foundations and special methodological issues of research in this area. We will focus on task-oriented groups, incorporating research from social psychology, sociology and organizational behavior. Class sessions will consist of discussion and "hands-on" practice of data collection and analysis methods.]

COMM 686(6860) Risk Communication
Spring. 3 credits. K. McComas and C. Scherer.
Examination of theory and research related to the communication of scientific information about environmental, agricultural, food, health, and nutritional risks. Concentrates on social theories related to risk perception and behavior. Examines case studies involving pesticide residues, waste management, water quality, environmental hazards, and personal health behaviors. Emphasizes understanding, applying, and developing theories of risk communication.

COMM 691(6910) Seminar: Topics in Communication
Fall and spring. 0 credits. S-U grades only. Staff.
Some weeks scholars from a wide variety of fields present varied topics in theory or research as it relates to communication; other weeks graduate students present thesis (project) proposals to faculty members and peers.

COMM 694(6940) Special Topics in Communication
Fall, spring, or summer. 1–3 credits, variable. Prerequisite: permission of instructor. S-U or letter grades.
Study of topics in communication not otherwise provided by a department course and determined by the interest of faculty members and students.

COMM 781(7810) Seminar in Psychology of Communication
Spring. 3 credits. Prerequisite: COMM 680 and 681 or equivalent graduate-level theory in psychology or social psychology. Letter grades. Offered odd-numbered years. M. Shapiro.
Discusses and analyzes selected current issues in the psychology of communication. Students discuss and synthesize current research and theory in the mental processing of communication.

COMM 794(7940) Seminar in Communication Issues
Fall, spring, or summer. 1–3 credits. Prerequisite: permission of instructor. Letter grades only.
Small group study of topical issue(s) in communication not otherwise examined in a graduate field course.

COMM 797(7970) Graduate Independent Study
Fall, spring, or summer. 1–3 credits. Prerequisite: permission of instructor. Letter grades only.
Individual study concentrating on locating, assimilating, synthesizing, and reporting existing knowledge on a selected topic.

COMM 798(7980) Communication Teaching Laboratory
Fall and spring. 1–3 credits each semester; may be repeated once. Prerequisite: graduate standing and permission of faculty member who will supervise work and assign grade. (Students must use faculty member's section number to register.) Letter grades only. Graduate faculty.
Designed primarily for graduate students who want experience in teaching communication courses. Students work with an instructor in developing course objectives and philosophy, planning, and teaching.

COMM 799(7990) Graduate Research
Fall, spring, or summer. 1–3 credits. Prerequisite: appropriate communication graduate course work or permission of instructor. Letter grades only.
Small-group or individual research based on original, empirical, data-based designs regarding topical issues in communication not otherwise examined in a graduate field course.

COMM 800(8900) Master's-Level Thesis Research
Fall or spring. 1–6 credits; may be repeated for max. of 6 credits. Prerequisite: permission of committee chair. S-U grades only.
Thesis research for M.S. (communication) students.

COMM 901(9900) Doctoral-Level Dissertation Research
Fall or spring. 1–9 credits; may be repeated for max. of 9 credits. Prerequisites: completion of "A" exam; permission of committee chair. S-U grades only.
Dissertation research for Ph.D. candidates.

CROP AND SOIL SCIENCES

S. D. DeGloria, chair (232 Emerson Hall, 255-5459); P. C. Baveye, D. Buckley, J. H. Cherney, W. J. Cox, A. DiTommaso, J. M. Duxbury, G. W. Fick, R. R. Hahn, P. Hobbs, Q. Ketterings, L. V. Kochian, J. Lehmann, A. Lembo, M. B. McBride, R. L. Obendorf, S. J. Riha, J. M. Russel-Anelli, T. L. Setter, J. E. Thies, H. M. van Es, A. Van Wambeke, O. Vatamaniuk, R. M. Welch

Courses by Subject

Crop Science: 311, 312, 315, 317, 403, 414, 426, 444, 455, 608, 610, 612, 613, 614, 642, 690, 691, 820, 920, 921

Environmental Information Science: 397, 410, 411, 420, 465, 485, 486, 620, 621, 660, 675, 694, 860, 960, 961

Soil Science: 260, 362, 363, 365, 372, 412, 421, 466, 471, 472, 483, 663, 666, 667, 669, 671, 672, 684, 693, 696, 880, 980, 981

General Courses

CSS 190(1900) Sustainable Agriculture: Food, Farming, and the Future
Fall. 3 or 4 credits, variable. Limited to 60 students. S-U or letter grades. G. W. Fick.
Designed to introduce basic food production resources in the context of the human aspects of farming. The information is of general value for nonmajors and students new to the field. Several field trips enhance appreciation for the diversity of agriculture. Students can earn 1 extra credit by participating in team preparation and delivery of a lesson in sustainable agriculture.

CSS 494(4940) Biotechnology and Development (also GOVT 430[4303])
Spring. 2 credits. Sec. 2. S-U or letter grades. J. E. Thies and R. J. Herring.
Of all the technological solutions to agronomic problems that have been proposed in the last few decades, none has created the level of backlash and controversy as those involving genetic biotechnology. Social protest and activist movements arise from ethical, cultural, religious, economic, environmental and political stances with regard to the use of transgenic technologies, particularly in agricultural development in poor countries. In this course, we will explore the roots of these controversies and follow the logics and economics of their development and deployment. We will try to identify the fundamental underpinnings of various arguments for and against the use of transgenic crops as a tool for agricultural development. Discussions on selected topics and associated directed readings will be led by the course coordinators and invited speakers. Students will be assessed on their participation in discussions and on a written position paper in the subject area.

CSS 494(4940) Special Topics in Crop and Soil Sciences (undergraduate level)
Fall or spring. 4 credits max. S-U or letter grades.
The department teaches "trial" courses under this number. Offerings vary by semester, and are advertised by the department before the semester begins. Courses offered under this number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

CSS 497(4970) Individual Study in Crop and Soil Sciences
Fall or spring. 1–6 credits. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall).
Topics in soil science, crop science, or environmental information science are arranged at the beginning of the semester for individual study or for group discussions.

CSS 498(4980) Teaching Experience in Crop and Soil Sciences
Fall or spring. 1–5 credits. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall).
Teaching experience in soil science, crop science, or environmental information science is obtained by assisting in the instruction of a departmental course. This course should not be taken by teaching assistants.

CSS 499(4990) Undergraduate Research
Fall or spring. Credit TBA. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall).
Independent research on current problems selected from any phase of crop science, soil science, or environmental information science.

CSS 690(6900) Scientific Method in Practice
Spring. 1 credit. Prerequisite: junior, senior, or graduate standing. S-U grades only. H. G. Gauch, Jr., and G. W. Fick.
Students in this course study Hugh Gauch's book *Scientific Method in Practice*, which is designed to help scientists become better scientists through deeper understanding of common themes that extend across the disciplines. Topics include the history and philosophy of science, reliance on evidence, deductive and inductive logic, probability, parsimony, and hypothesis testing.

CSS 696(6960) Seminar in Crop and Soil Sciences
Fall and spring. 1 credit. S-U grades only. Staff.
Covers current research and selected topics in the crop and soil sciences and related fields.

CSS 696(6960) Agroecological Perspectives for Sustainable Development
Fall and spring. Sec 2. 1 credit. S-U grades only. Staff.
Agroecological perspectives for sustainable development.

Crop Sciences

CSS 311(3110) Grains and Nutraceuticals
Fall. 4 credits. Prerequisite: CSS 260 or BIOPL 241 or permission of instructor. One or two field trips during lab periods. R. L. Obendorf.
Globally, six seed crops provide 75 percent of the caloric and protein needs of mankind by direct consumption or indirectly through animal and microbial products. Seed crops for starch, protein, oil, fiber, sugar, nutraceutical, pharmaceutical, and industrial uses are emphasized, including adaptation, growth and development, environmental stress, optimization of yield and quality, and genetic improvement in the context of food systems for improved health. Laboratory uses living plants, an extensive crop garden, and computer simulation.

CSS 312(3120) Forage Crops
Spring. 4 credits. Prerequisite: introductory crop and/or soil science course. Recommended: animal nutrition course. G. W. Fick.
Considers the production and management of crops used for livestock feed in terms of establishment, growth, maintenance, harvesting, and preservation. Emphasizes forage grasses, forage legumes, and corn and considers their value as livestock feed in terms of energy, protein, and other nutritional components.

CSS 315(3150) Weed Biology and Management
Fall. 4 credits. Prerequisite: introductory course in biology or botany. A. DiTommaso.
Examines principles of weed science. Emphasizes (1) weed biology and ecology; (2) weed-management strategies used in agricultural and natural ecosystems; and (3) chemistry of herbicides in relation to effects on plant growth and the environment. Hands-on laboratory sessions cover weed identification and ecology, herbicide application, selectivity, and symptomology.

CSS 317(3170) Seed Science and Technology (also HORT 317[3170])
Fall. 3 credits. Prerequisite: BIOPL 241 or equivalent. Two all-day field trips. Offered alternate years. A. G. Taylor, Geneva Experiment Station. (Ithaca contact, R. L. Obendorf.)
The principles and practices involved in the production, harvesting, processing, storage, testing, quality management, certification, and use of high-quality seed from improved cultivars. Information is applicable to various kinds of agricultural seeds. Hands-on laboratory experience.

CSS 403(4030) Traditional Agriculture in Developing Nations (also IARD 403[4030])
Fall. 1 credit. S-U grades only. P. Hobbs.
Half the world's arable land is farmed by traditional farmers who have produced food and fiber for millennia with few outside inputs. Many of these practices are forgotten but some are still used by farmers in developing countries. This course examines the pros and cons of some of these traditional systems.

CSS 414(4140) Tropical Cropping Systems: Biodiversity, Social, and Environmental Impacts (also IARD 414[4140])
Fall. 3 credits. Prerequisite: introductory crop science or soil science or biology course or permission of instructor. P. Hobbs.
Characterizes and discusses traditional shifting cultivation; lowland rice-based systems; upland cereal-based systems; smallholder mixed farming including root crops and livestock; plantation fruit and oil crop systems; and agroforestry. In addition to species diversity and domestication, factors such as climate, land quality, soil management, land tenure, labor, and markets are considered. Evaluates the impact of tropical cropping systems on the environment.

CSS 426(4260) Practicum in Forest Farming as an Agroforestry System (also HORT/NTRES 426[4260])
Fall. 2 credits. K. W. Mudge, L. E. Buck, and P. Hobbs.
For description, see HORT 426.

CSS 444(4440) Integrated Pest Management (also ENTOM 444[4440])
Fall. 4 credits. Prerequisites: biology course or permission of instructor. J. E. Losey and A. DiTommaso.
For description, see ENTOM 444.

CSS 455(4550) Mineral Nutrition of Crops and Landscape Plants (also HORT 455[4550])
Spring. 3–5 credits. Prerequisite: CSS 260 and BIOPL 242, or equivalent. Offered alternate years. H. C. Wien and staff.
Modular course on principles of plant mineral nutrition and nutrient management. A mandatory module on principles is followed

by others on agronomic crops, vegetables, floriculture, and fruit crops. Each module carries 1 credit; a minimum of 3 credits must be taken in one semester. By the end of the course, students understand the principles of mineral nutrient function in crop plants, and are able to diagnose deficiencies by symptoms and tissue tests and devise organic and conventional nutrient management schemes that maximize productivity and mineral nutrient quality.

CSS 608(6080) Water Status in Plants and Soils
Fall. 1 credit. Prerequisite: permission of instructor. S-U grades only. Offered alternate years. T. L. Setter.
This is a lecture and lab course that introduces students to techniques for field appraisal of the status of water in plants and soil, including methods used in physiological studies, such as the psychrometer, pressure chamber, gas exchange analyzer, soil water content analyzers, sap flow instrumentation, and abscisic acid analysis with ELISA.

[CSS 610(6100) Physiology of Environmental Stresses
Fall. 3 credits. Prerequisite: plant physiology course (BIOPL 242 or 342) or permission of instructor. Offered alternate years; next offered 2008–2009. T. L. Setter.
Study of the responses of plants to environmental stresses, including drought, high temperature, salinity, chilling, freezing, hypoxia, and toxic elements. Emphasizes the physiological and biochemical basis of injury and plant resistance mechanisms at the whole-plant, cellular, and molecular levels.]

CSS 612(6120) Seed Biology
Fall. 3 credits. Prerequisite: plant physiology course or permission of instructor. R. L. Obendorf.
Describes the molecular, biochemical, physiological, environmental, and genetic regulation of seed development, maturation, and germination events, including the deposition and mobilization of seed reserves with illustrations from the world's major food and feed seeds. Illustrations extend the principles to practical situations, industrial uses, and food systems for improved health.

CSS 613(6130) Physiology and Ecology of Yield
Spring. 3 credits. Prerequisite: plant physiology course (BIOPL 242 or 342) or permission of instructor. T. L. Setter.
Study of environmental constraints on crop–plant productivity from the perspective of key biological processes. Examines acclimation responses and genetic adaptation for temperature, light, water, compacted soil, and mineral-limited nutrient environments. Topics include photosynthesis and nitrogen assimilation, phloem translocation and partitioning; canopy-scale influences on solar radiation use efficiency; regulation of growth processes in leaf, root, and floral/fruit/grain sinks in response to environment; seed set; water transport and stomatal regulation; root architecture and function, behavior in water-limited situations. Students will develop an ability to identify processes that are in need of improvement through optimization of crop cultural practices or genetic change.

[CSS 614(6140) Weed Ecology and Management
Spring. 3 credits. Prerequisite: CSS 315 or equivalent. Offered alternate years; next offered 2008–2009. A. DiTommaso.
Examination of plant ecological principles governing weed population dynamics and weed-crop competitive interactions in different crop and noncrop ecosystems. Explores the application of these fundamentals for the development and implementation of environmentally sound and sustainable integrated weed management strategies. Topics include seed biology and seedbank dynamics, weed demography and spatial variation, weed-crop interference, invasive weed biology, biological weed control, and site-specific weed management.]

[CSS 642(6420) Mineral Nutrition: From Plants to Humans (also BIOPL 642[6420])
Spring. 3 credits. Prerequisite: BIOPL 341 or equivalent. Offered odd-numbered years; next offered 2008–2009.
O. Vatamaniuk, L. V. Kochian, and R. M. Welch.
This course focuses on the biophysical, biochemical, molecular and physiological processes by which plants absorb mineral nutrients from the soil, translocate, and utilize them for growth and development. Selected lectures will focus on the relation between the nutrient status of plants and human nutrition and health. Students will be also exposed to state-of-the-art techniques that are used for analyses of mineral status of plants.]

CSS 691(6910) Special Topics in Crop Science
Fall or spring. 1–6 credits. S-U or letter grades. Staff.
Study of topics in crop science that are more specialized or different from other courses. Special topics to be offered depend on staff and student interests.

CSS 820(8200) Master's-Level Thesis Research in Crop Science
Fall or spring. Credit TBA. S-U grades only. Graduate faculty.
Thesis research for M.S. candidates.

CSS 920(9200) Graduate-Level Thesis Research in Crop Science
Fall or spring. Credit TBA. S-U grades only. Graduate faculty.
Thesis research for Ph.D. students *before* "A" exam has been passed.

CSS 921(9210) Doctoral-Level Dissertation Research in Crop Science
Fall or spring. Credit TBA. S-U grades only. Graduate faculty.
Dissertation research for Ph.D. candidates **after** "A" exam has been passed.

Environmental Information Science

CSS 397(3970) Environmental Microbiology [also BIOMI 397(3970)]
Spring. 3 credits. Prerequisite: BIOEE 261 or BIOMI 290 or CSS 260 or permission of instructor. Offered alternate years.
E. L. Madsen.
Discusses the biology, behavior, and function of microorganisms in natural environments in relation to past and present environmental conditions on Earth. Also considers the role of microorganisms in ecologically and environmentally significant processes through discussion of specific topics such as elemental cycles, nutrient cycling, transformation of pollutant chemicals, wastewater treatment, and environmental biotechnology.

CSS 410(4100) The GMO Debate: Environmental Impacts
Spring. 3 credits. Prerequisite: BIO G 109 or equivalent. D. Buckley and P. Hobbs.
This course covers issues pertaining to the agricultural use of genetically modified organisms with emphasis on evaluating their environmental impact. Students will learn to critically evaluate the risks of benefits associated with the use of GMOs. We will examine the types of GMOs in use and in development, how they are made, and their potential impacts on the environment including: gene flow, non-target effects, horizontal gene transfer, biodiversity effects and the implications of changes in farming practices and chemical inputs.

CSS 411(4110) Resource Inventory Methods (also CEE 411[4110])
Spring. 3 credits. Prerequisite: permission of instructor. A. Lembo.
Survey of resource inventory methods applied to field-based studies of environmental systems. Laboratory emphasizes using maps, spatial databases, global positioning systems, and aerospace imagery to discriminate, measure, inventory, and monitor environmental resources.

CSS 420(4200) Geographic Information Systems
Fall. 4 credits. Prerequisite: CSS 411 or permission of instructor. A. Lembo.
Principles and applications of geographic information systems for the characterization and assessment of agronomic and environmental resources. Emphasizes methods for accessing, updating, analyzing, and mapping spatial data and information. Considers needs assessment, coordinate systems, spatial and attribute database design and maintenance, modeling and analysis, and Internet map servers.

CSS 465(4650) Global Positioning System
Fall, first five Fri. of semester. 1 credit. Prerequisite: CSS 411 or 420, or equivalent, or permission of instructor.
Spring, last five Fri. of semester. 1 credit. Prerequisite: CSS 411 or 420, or equivalent, or permission of instructor.
A. Lembo.
Introduction to navigation-grade GPS instruments used in agricultural and environmental science. Topics include instrument familiarization; field-data collection and processing; real-time and post-differential correction; and GPS-GIS integration.

[CSS 485(4850) Problem Solving in Environmental and Agroecosystem Science I
Fall. 4 credits. Prerequisite: senior standing, CSS 260 or equivalent.
P. Baveye.
Capstone experience for seniors, centering on the pluridisciplinary analysis of a specific problem (e.g., a brownfield in Ithaca in fall 2004), with a number of faculty members serving as technical resources and lecturing as needed. Involves field trips, in-depth discussions of data assembled before the course, gathering of relevant scientific

information (in groups), and report writing. Students are expected to work approximately 15 hours per week on a range of assignments. The course is conceived as the first of a sequence of two complementary courses, but it can be taken alone.]

[CSS 486(4860) Problem Solving in Environmental and Agroecosystem Science II
Spring. 4 credits. Prerequisite: senior standing, CSS 485. P. Baveye.
Capstone experience for seniors, in continuation of CSS 485. Students work in groups to carry out the laboratory measurements identified in the fall, with faculty members serving as technical support and lecturing as needed. Students are expected to work approximately 15 hours per week on a range of laboratory measurements. The results of these measurements are discussed as they become available and are combined with the rest of the assembled information to come up with recommendations about the management of the targeted problem (e.g., in spring 2005, a brownfield in Ithaca).]

CSS 620(6200) Spatial Modeling and Analysis
Spring. 3 credits. Prerequisites: CSS 420, 461, or permission of instructor. A. Lembo.
Theory and practice in the development, integration, and visualization of spatial data for resource inventory, environmental process modeling, land classification, and evaluation. Emphasizes application and evaluation of advanced spatial analytical methods applied to environmental systems and databases of interest to the student.

CSS 621(6210) Applications of Space-Time Statistics
Spring. 2 credits. Prerequisite: STBTRY 601 or equivalent. S-U grades only. Offered alternate years; offered after spring break 2008. H. Van Es.
Introduction to space-time statistics with applications in agriculture and environmental management. Topics include geostatistics, temporal statistics, sampling, experimental design, state-space analysis, data mining, and fuzzy logic. Focuses on landscape-scale processes and a user's perspective.

CSS 660(6600) Remote Sensing Fundamentals (also CEE 610[6100])
Fall. 3 credits. Prerequisite: permission of instructor. W. D. Philpot.
Introduces equipment and methods used in obtaining information about earth resources and the environment from aircraft or satellite. Covers sensors, sensor and ground-data acquisition, data analysis and interpretation, and project design.

CSS 674(6740) Environmental Genomics
Fall. 2 credits. S-U or letter grades. D. H. Buckley.
Genomics opens new avenues for exploring interactions between organisms and their environment. Through lectures and discussion of current research we will learn how genomic tools can provide insight on processes occurring at individual, population, and ecosystem scales that govern the response of biological systems to environmental change. Emphasis will be placed on microbial systems, but this course will also be useful to those interested in other applications of environmental genomics. The course will provide students with experience in writing and reviewing grant proposals by culminating in the creation of short research proposals to be reviewed by the class in the style of an NSF panel.

[CSS 675(6750) Modeling the Soil-Plant-Atmosphere System (also EAS 675[6750])
Spring. 3 credits. Prerequisite: CSS 483 or equivalent. Offered alternate years; next offered 2008–2009. S. J. Riha.
Introduction to the structure and use of soil-plant-atmosphere models. Topics include modeling plant physiology, morphology, and development; potential crop production and crop production limited by moisture and nutrient availability; plant-plant competition; and land surface processes as well as model data requirements, validation, and scale. Discusses use of soil-plant-atmosphere models for teaching, research, extension, and policy formation.]

CSS 694(6940) Special Topics in Environmental Information Science
Fall or spring. 1–6 credits. S-U or letter grades. Staff.
Study of topics in environmental science that are more specialized or different from other courses. Special topics covered depend on staff and student interests.

CSS 860(8600) Master's-Level Thesis Research in Environmental Information Science
Fall or spring. Credit TBA. S-U grades only. Graduate faculty.
Thesis research for master's students.

CSS 960(9600) Graduate-Level Dissertation Research in Environmental Information Science
Fall or spring. TBA. S-U grades only. Graduate faculty.
Dissertation research for Ph.D. students *before* "A" exam has been passed.

CSS 961(9610) Doctoral-Level Dissertation Research in Environmental Information Science
Fall or spring. Credit TBA. S-U grades only. Graduate faculty.
Dissertation research for Ph.D. candidates **after** "A" exam has been passed.

Soil Science

CSS 260(2600) Soil Science
Fall. 4 credits. S-U or letter grades. J. Russell-Anelli.
Designed for students interested in a comprehensive introduction to soil science from both an environmental and plant management perspective. Divided into three units: (1) soil information unit introduces students to soil characterization, testing, mapping, classification, GIS, and land evaluation. (2) soil management unit addresses fertility, pest management, water, and microclimate, as well as erosion, conservation, pollution, and soil health. (3) unit on the role of soils in ecosystems considers topics such as biodiversity, soils as sinks and sources of greenhouse gases, and the impact of soils on land use. Labs are initially field-oriented with an emphasis on learning practical skills needed to evaluate and manage soils. Subsequent labs focus on accessing, interpreting, and applying soil information.

[CSS 362(3620) Soil Morphology
Fall. 1 credit. Prerequisite: undergraduate standing. Recommended for sophomores and juniors. One all-day field trip required. Next offered 2008–2009. J. Russell-Anelli.
Presents the principles for field identification of soil properties, profiles, and landscapes. A series of soil pits are examined, described, classified, and interpreted in the field.]

CSS 363(3630) Soil Genesis, Classification, and Survey
Fall. 4 credits. Prerequisite: CSS 260. One all-day field trip required. J. Russell-Anelli.
Discusses factors and processes of soil formation on which soil survey is based. Practices principles of field identification, classification, survey, and interpretation in a field setting. Provides an overview of soil databases, their content, development, and use for site evaluation and land classification.

CSS 365(3650) Environmental Chemistry: Soil, Air, and Water
Spring. 3 credits. Prerequisites: CHEM 207–208 or CHEM 206. M. B. McBride.
Overview of the chemical processes that control the fluxes, concentrations, and bioavailability of nutrients and pollutants in soil, air, and water. Gives particular attention to soil's function as a filter for contaminants. Describes the history of environmental contamination by xenobiotics and heavy metals, with emphasis on behavior and properties of pollutants that pose the greatest risk to human and ecological health.

CSS 372(3720) Nutrient Management in Agroecosystems
Spring. 4 credits. Prerequisite: CSS 260 or permission of instructor. Graduate students should enroll in CSS 472. J. Lehmann.
Familiarizes students with the basic concepts of soil fertility and biogeochemistry and how soil and environmental properties affect nutrient availability and cycling. Discussion focuses on the way organic farming and soil conservation affect the fate of nutrients in agroecosystems. Emphasizes how nutrient management can be improved without creating environmental hazards. Students have hands-on training in analytical procedures and expand knowledge in discussion groups and through oral as well as poster presentations.

CSS 412(4120) Whole-Farm Nutrient Management (also AN SC 412[4120])
Spring. 2- or 4-credit option. Prerequisite: AN SC 411; junior, senior, or graduate standing. Offered as two modules. Enrollment in Module 1 for first half of semester required (2 credits); consists of crop and manure nutrient management planning; no prerequisites for CALS students. Enrollment in Module 2 for second half of semester optional (additional 2 credits). M. E. VanAmburgh and Q. M. Ketterings.
For description, see AN SC 412.

CSS 421(4210) Soil and Water Management
Fall. 4 credits. Prerequisite: CSS 260. S-U or letter grades. H. M. van Es.
Introduces students to the principles of soil and water interactions and the effects of human intervention. Examines soil hydrology, soil erosion and conservation, water and soil quality, contaminant movement, soil health, tillage, and soil compaction. Discusses case

studies and policy approaches from both the United States and abroad.

CSS 466(4660) Soil Ecology (also HORT 466[4660])
Spring. 4 credits, with lab. Prerequisite: one year of biology or ecology and CSS 260 or permission of instructor.
J. E. Thies.
Discover the wonder of life underground. In this course, you will study the amazing diversity of soil organisms along with their multifaceted functions in terrestrial ecosystems. The fundamental principles and features of biologically-mediated processes in the soil and the functions of soil biota in both managed and unmanaged ecosystems will be highlighted. Special topics include: beneficial symbioses, biological control of plant pathogens, biogeochemistry of unique habitats, bioremediation and composting of organic wastes, among others. Laboratory focuses on molecular activities and traditional methods for assessing the abundance, activity, and diversity of soil organisms.

[CSS 471(4710) Properties and Appraisal of Soils of the Tropics
Spring. 3 credits. Prerequisite: CSS 260 or equivalent. S-U or letter grades. No auditors. Next offered 2008–2009.
A. VanWambeke.
Examines the conditions in which soils form, and considers ecological, geological, and vegetational factors that produce the diversity that exists among them. The major kinds of soils are recognized, their management properties described, and methods to alleviate the constraints to crop production and preservation of the environment are examined. Topics include the identification of soils, and their functions in sustaining traditional farming systems and advanced technological packages. The course pursues these themes reviewing the most recent sources of information generated in tropical countries and published in Latin-American, French, and English journals. The last part of the course gives special attention to salt-affected soils, paddy rice cultivation, and the characteristics of acid-sulfate soils. Lectures include slides of soils, landscapes, and cropping systems. The course is available on a compact disk in Mann Library.]

CSS 472(4720) Nutrient Management and Research in Agroecosystems
Spring. 4 credits. Prerequisite: CSS 260 or permission of instructor. J. Lehmann.
Familiarizes students with the basic concepts of soil fertility and biogeochemistry and how soil and environmental properties affect nutrient availability and cycling. Discussion focuses on the way organic farming and soil conservation affect the fate of nutrients in agroecosystems. Emphasizes the way nutrient management can be improved without creating environmental hazards. Gives students hands-on training in analytical procedures and expand knowledge in discussion groups and through oral as well as poster presentations. The laboratory experiments conclude with a final paper.

CSS 483(4830) Environmental Biophysics (also EAS 483[4830])
Spring. 3 credits. Prerequisite: CSS 260 or equivalent or permission of instructor.
S. J. Riha.
Introduction to basic principles of energy and mass transfer and storage in soil-plant systems. Covers energy budgets; soil heat flow; water movement in saturated and unsaturated soils; evapotranspiration; and water, gas, and nutrient dynamics in the soil-plant-atmosphere continuum. Considers applications to agronomic and environmental problems and instrument design and use through discussion and problems sets.

[CSS 663(6630) Pedology
Spring. 3 credits. Prerequisite: CSS 361 or permission of instructor. Offered alternate years; next offered 2008–2009. J. Russell-Anelli.
Weathering, reactions, and processes of soil genesis; principles of soil classification and the rationale and use of soil taxonomy; development and significance of major groups of soils of the world.]

CSS 666(6660) Applied Plant–Microbe Interactions
Fall. 4 credits. Prerequisite: CSS 466 or equivalent or permission of instructor. Offered alternate years. J. E. Thies.
This is a discussion and laboratory-based course that focuses on the nature of microbial interactions with plants, and concentrates largely on bacterial and fungal associations. Students will investigate symbiotic, associative, endophytic, and pathogenic interactions. The main aim of this subject is to help the students improve their professional practice within the content area. Students will learn to examine the primary literature, present research reports, write and review proposals, conduct a small independent-research project, and report on the outcomes in conference and journal formats. Class discussions will explore the nature of the rhizosphere and phyllosphere environments as a habitat for microorganisms and the ecology of the organisms residing there through readings in the primary literature. In laboratory, all students will conduct an independent research project, aligned with their interests, in which they develop testable hypotheses and conduct experiments using relevant, modern methods.

[CSS 667(6670) Advanced Soil Physics
Spring. 3 credits. Prerequisites: one year of college physics and CSS 483 or permission of instructor. S-U or letter grades. Offered alternate years; next offered 2008–2009. Staff.
Acquaints students with advanced topics in soil physics in a number of areas, including the statics and thermodynamics of soil water, the physics of swelling-shrinking soils, the transport of water and solutes in heterogeneous soils, the measurement of soil physical parameters, and the effect of spatial/temporal heterogeneity of soils on their physical characteristics. The format of the course, based in most years on weekly, individual tutorials, allows different topics to be covered, depending on the interest(s) of the students. If a group of students expresses interest, the course also can involve reflection on the detailed design of one or more laboratory or field experiments related to soil physics.]

CSS 669(6690) Organic Matter—Soils, Sediments, and Waters
Spring. 3 credits. Prerequisites: CSS 260 and CHEM 357–358 or equivalent.
J. M. Duxbury.
Discussion of current concepts on the chemical nature, dynamics, and properties of natural organics and organo-mineral associations in terrestrial and aquatic environments. Includes a modeling project of soil carbon dynamics in natural or agricultural ecosystems.

[CSS 671(6710) Soil Chemistry
Fall. 3 credits. Prerequisite: one year of physical chemistry or permission of instructor. Offered alternate years; next offered 2008–2009. M. B. McBride.
Detailed examination of the structure and surface chemistry of colloidal particles important to the function of soils. Emphasizes ion exchange; mineral-solution equilibria; and adsorption reactions of silicate clays, oxides, and organic matter. Describes the sorption behavior of environmental contaminants in soils, particularly metals and xenobiotics.]

[CSS 672(6720) Nutrient Cycling in Natural and Managed Ecosystems
Fall. 3 credits. Prerequisite: CSS 372 or NTRES 321 or BIOEE 478, or permission of instructor. Offered alternate years; next offered 2008–2009. J. Lehmann.
Covers nutrient cycling in soil and the interface between the soil and the biosphere, atmosphere, and hydrosphere. Examines the biogeochemistry of nutrient elements in natural ecosystems, disturbed or degraded ecosystems, and agricultural systems, including pollution in watersheds. Students develop independent projects, present a research proposal, and conduct field research that culminates in a presentation and a paper in publishable format.]

[CSS 684(6840) Topics in Soil Microbial Ecology
Fall. 1 credit. Disc. Next offered 2008–2009. S-U grades. D. Buckley.
Seminar and discussion course dealing with current topics in soil microbial ecology including: Community ecology and diversity, microbial biogeography, biogeochemistry, plant-microbe interactions, microbial feedbacks on plant communities, gene exchange and evolution in soils, soil microbial genomics, and relationships between structure and function of microbial communities in soil systems.]

CSS 693(6930) Special Topics in Soil Science
Fall, spring, or summer. 1–6 credits. S-U or letter grades.
Study of topics in soil science that are more specialized or different from other courses. Special topics covered depend on staff and student interests.

CSS 696(6960) Seminar: Organic Inputs in Tropical Soils and Agroforestry (also NTRES/IARD 696[6960])
Fall, spring. 1 credit sec 2. S-U grades only. E. Fernandes and L. Fisher.
A variety of speakers present seminars on agroecological perspectives for (primarily international) sustainable development. Students are required to prepare a synopsis of each seminar.

CSS 880(8880) Master's-Level Thesis Research in Soil Science
Fall or spring. Credit TBA. S-U grades only. Graduate faculty.
Thesis research for master's students.

CSS 980(9800) Graduate-Level Dissertation Research in Soil Science
Fall or spring. Credit TBA. S-U grades only. Graduate faculty.

Dissertation research for Ph.D. students **before** "A" exam has been passed.

CSS 981(9810) Doctoral-Level Dissertation Research in Soil Science
Fall or spring. Credit TBA. S-U grades only. Graduate faculty.
Dissertation research for Ph.D. candidates **after** "A" exam has been passed.

DEVELOPMENT SOCIOLOGY

M. J. Pfeffer, chair (133A Warren Hall, 255-1676); D. L. Brown, P. Eloundou-Enyegue, S. Feldman, J. D. Francis, C. C. Geisler, A. Gonzales, D. T. Gurak, T. A. Hirschl, F. Makki, P. D. McMichael, R. L. Mize, L. B. Williams

D SOC 101(1101) Introduction to Sociology (SBA) (KCM) (D)
Fall or spring. 3 credits. Fall, T. Hirschl; spring, Students may not take both D SOC 101 and SOC 101 for credit. A. Gonzales.
Introduction to theory and research in sociology. Demonstrates how the insights, theories, and methods of sociological analysis can be brought to bear on major issues of social life. A primary goal is to convey a sense of the manner in which sociologists formulate theories and how the collection and analysis of data are used to evaluate those theories. Provides "hands-on" experience in analyzing sociological issues. Students undertake guided research exercises that involve using computers to analyze actual data. No prior background is presumed; necessary skills are covered in class and section meetings.

D SOC 111(1201) Development Sociology First-Year Writing Seminar (SBA)
Fall, spring. 3 credits. Staff.
The department offers first-year writing seminars on a wide range of development sociology topics. Consult John S. Knight Writing Seminar Program brochures for instructors and descriptions.

D SOC 112(1200) Development Sociology First-Year Writing Seminar (SBA)
Fall, spring. 3 credits. Staff.
The department offers first-year writing seminars on a wide range of development sociology topics. Consult John S. Knight Writing Seminar Program brochures for instructors and descriptions.

D SOC 201(2010) Population Dynamics (also SOC 202[2202]) (SBA)
Spring. 3 credits. Limited to 35 students. ALS students must enroll in D SOC 201. S-U or letter grades. D. Brown.
This course provides an introduction to population studies. The primary focus is on the relationships between demographic processes (fertility, mortality, and immigration) and social and economic issues. Discussion will cover special topics related to population growth and spatial distribution, including marriage and family formation, population aging, changing roles and statuses of women, labor force participation, immigrations, urban growth and urbanization, resource allocation, and the environment.

D SOC 205(2050) International Development (also SOC 206[2206]) (SBA) (HA) (D)
Spring. 3 credits. Limited to 74 students. P. McMichael.
Examines new questions concerning development models in the post–Cold War era from a comparative and global perspective on North-South relations. While the focus is the "Third World," the issues confronting it are often global, even when they concern the most basic issue of food security. Using films and various theoretical perspectives, the course examines Southern societies (economies, ecologies, class/gender relations) and the impact of global forces on Southern resources. Such forces include global food systems, new forms of export production, development agencies, multilateral institutions, local bureaucracies, transnational corporations, the debt crisis, and new technologies. Also examines the new global justice movements, such as environmentalism, feminism, and landless workers, peasant, and grassroots activism.

D SOC 207(2070) Problems of Contemporary Society (also SOC 207[2070]) (SBA)
For description, see SOC 207.

D SOC 209(2090) Social Inequality (also SOC 208[2208]) (SBA)
For description, see SOC 208.

D SOC 215(2150) Introductory Organizations (also SOC 215[2150]) (SBA)
For description, see SOC 215.

D SOC 220(2200) Sociology of Health of Ethnic Minorities (also LSP 220[2200]) (SBA) (D)
Fall. 3 credits. Limited to 15 students. S-U or letter grades. P. A. Parra.
Discusses the health status of minorities in the United States. Explores intragroup diversity such as migration, economic status, and the influence of culture and the environment on health status and access to health care. Although special attention is given to Latino populations, discussion encompasses other minorities who face similar problems.

D SOC 222(2220) Controversies About Inequality
For description, see SOC 222.

D SOC 275(2750) Immigration and a Changing America (D) (SBA) (HA)
Spring. 3 credits. S-U or letter grades. D. Gurak.
Immigration helped America become the nation that it is today. While many experts thought that immigration's contribution to American history ended in the early 1900s, immigration surged to historic highs in the second half of the 20th century and shows no signs of diminishing in the 21st century. This course examines the economic, social, and policy forces that underlie contemporary U.S. immigration and the impacts that immigrants are having on the American economy and society today. It looks in detail at who the new immigrants are, why they come to America, where they live, and what roles they fill in America.

D SOC 301(3010) Theories of Society and Development (SBA) (KCM)
Spring. 3 credits. Limited to 30 students. Prerequisites: development sociology or sociology course. S-U or letter grades. F. Makki.
Introduction to the "classical" sociological theorists (Marx, Weber, Durkheim) of the late 19th and early 20th century. Also addresses the dramatic social upheavals of the industrialization, capitalism, and rise of bureaucracy to which these thinkers reacted and the inspiring (and conflicting) visions for the future which they offered. Emphasizes the intellectual history, the influence of the theorists on subsequent sociology, and the potential for relevance to contemporary society.

D SOC 305(3050) Education, Inequality, and Development (SBA)
Spring. 3 credits. Prerequisite: introductory social science course or permission of instructor. Letter grades. P. Eloundou-Enyegue.
The main goal of this course is to examine the functions of education institutions, as they affect individual welfare, inequality, and development. It begins with a review of basic definitions and measures of education, inequality, and development, it then examines the individual and societal functions of education, from theoretical perspectives drawn from sociology, economics, and demography. The insights from these various perspectives are examined critically. The course also reviews studies that have examined how investments in education appear to affect selected outcomes.

D SOC 313(3130) Social Indicators and Introduction to Social Science Research (SBA)
Fall. 3 credits. P. Eloundou–Enyegue.
This course is an introduction to social science research. It reviews the general process through which social scientists derive credible answers to important questions about social change and social influences on individual behavior. It covers all steps in the research process, from the formulation of a research question to the final presentation of findings. The course is designed as a preparation for future work in social science research, but it is also intended for students who simply want to sharpen their capacity to evaluate the claims made by researchers. The course combines theory and application. A real-life research project on campus is used to apply the concepts and ideas from the textbook and lectures.

D SOC 314(3140) Spatial Thinking, GIS, and Related Methods (SBA) (KCM)
Spring. 4 credits. Letter grades only. J. Francis.
Everything occurs in space. Knowing where organizations are located and events occur in space provides clues to understanding social order and processes not revealed by traditional social analysis techniques. At the same time, spatial thinking and methods are becoming increasingly used in the social sciences. The purpose of this course is to introduce the undergraduate to both aspects of spatial patterns, trends, and themes but also to methodologies for bringing spatial considerations into their research. The course will provide a practical introduction to GIS via lab assignments.

D SOC 324(3240) Environment and Society (also S&TS 324[3241], SOC 324[3240]) (SBA)
Fall and spring. 3 credits. Fall, C. Geisler; spring, G. Gillespie.

The main objective is to develop a critical understanding of the dominant trends in modern U.S. environmental thought, such as preservationism, conservationism, deep ecology, social ecology, NIMBYism, risk assessment, ecological modernization, and environmental equity. A second objective is to familiarize students with some major contemporary substantive environmental problems and policies. These topics include air and water quality, public lands management, biodiversity, deforestation, climate change, and ozone depletion. A sociological framework is applied to evaluate interrelationships of substantive and philosophical/theoretical issues.

D SOC 331(3310) Environmental Governance
For description, see NTRES 331.

D SOC 336(3360) Rural Areas in Metropolitan Society (SBA)
Spring. 3 credits. Prerequisite: social science course. D. Brown.
Analyzes the changing structure and role of small towns and rural areas in developed nations. Focuses on adaptation of rural communities and populations to major trends, including increased societal differentiation and complexity; increased societal interdependence; and rapid social, economic, technological, and ecological change. Considers alternative policies to ameliorate rural problems and/or enhance rural contributions to national development. Students participate in group research projects in rural communities.

D SOC 340(3400) Agriculture, Food, and Society (SBA) (KCM)
Fall. 3 credits. S-U or letter grades. G. W. Gillespie.
Changing food and agricultural systems reflect the development patterns and social organization of an increasingly global society. Sociological questions include: What are major trends? What drives them? What benefits and costs accrue to people, communities, and ecosystems? How can we evaluate issues in such a way as to promote problem-solving? What development strategies might better manifest shared values?

D SOC 355(3550) Latinos, Law, and Identity
Fall. 3 credits. Prerequisite: D SOC 101 or permission of instructor. R. Mize.
Critical exploration of the critical justice movement and Latina/o identities. Legal cases, federal and state laws, and constitutional issues that impact Latina/os residing in U.S. highlighted. Theoretical contributions of law and society, critical race theory, LatCrit, and outsider jurisprudence perspectives applied to precedent-setting cases and current attempts at marginalizing/empowering Latina/o communities.

D SOC 370(3700) Comparative Social Inequalities (also SOC 371[3710]) (D) (SBA)
Fall. 3 credits. Prerequisite: introductory social science course. R. Mize.
Reviews both classical and contemporary issues in the comparative study of social inequality. Employing a global perspective, the course examines various relations of inequality—in the labor market and the reorganization of work and employment and in relation to questions of difference—of race, gender, ethnicity, sexuality, and ability—as these pattern unequal access to resources, differentially provide economic and social security, and shape life chances and lived experiences. Throughout the course special attention is given to the importance of understanding patterns of change in relation to the reconfiguration of global production, consumption, and migration.

D SOC 375(3750) Comparative U.S. Racial and Ethnic Relations (also AM ST/LSP 375[3750]) (D) (SBA) (HA)
Spring. 3 credits. Prerequisite: D SOC 101 or permission of instructor. Letter grades only. R. L. Mize.
A comparative historical study of the social construction of race. Examines structures of racism as they influence Latina/o, African American, Native American, and Asian American experiences. Does a critical interrogation of whiteness and ethnic identities. Focuses on historical legacy of institutional and interpersonal racism and its contemporary relevance in terms of political economic, residential, legal, educational, cultural, health, and social-psychological inequalities.

D SOC 380(4900) Independent Honors Research in Social Science (SBA) (KCM)
Fall and spring. 1–6 credits; 6 credits max. may be earned in honors program. Prerequisite: requirements for honors program met. J. Francis.
Students should select a faculty advisor and begin proposal development during the junior year. Students must submit written proposals by the third week of the semester of their senior year to the departmental honors committee representative.

D SOC 410(4100) Health and Survival Inequalities (also SOC 410[4100]) (D) (SBA)
Fall. 4 credits. S-U or letter grades. A. Basu.
Historical inequalities in health and survival continue to exist today. This course will cover some of the markers of such inequalities, including region, class, race, gender, and age and examine some of the biological, socioeconomic and political determinants of these differences. Macro as well as individual and family level determinants will be examined. Policy prescriptions will be evaluated and new innovative approaches proposed.

D SOC 421(4210) Theories of Reproduction (also SOC 421[4210]) (D) (SBA)
Spring. 4 credits. S-U or letter grades. A. Basu.
Examines the contentious debate of what makes women have any, few, and many children. It covers theories of population growth and changing fertility in both historical and contemporary populations. Demographic concepts like "the demographic transition" and "natural fertility" are discussed. Primary attention is given to "sociocultural" and "gender-based" explanations of reproductive behavior. The course also looks at theories about the place of the state in women's lives.

D SOC 430(4300) Human Migration: Internal and International
Fall. 3 credits. Prerequisite: one demography course or permission of instructor. D. Brown.
This course analyzes the determinants and consequences of internal and international migration in developed and developing nations. Multilevel and multidisciplinary approaches are emphasized. Public policy implications of the volume and composition of migration for origin and destination communities are examined. Techniques and measurement issues are discussed.

D SOC 432(4320) Environmental Strategies
For description, see NTRES 431.

D SOC 438(4380) Population and Development (also SOC 437[4370])
Spring. 3 credits. Prerequisite: permission of instructor. D. Gurak.
Examines major historical and recent demographic transitions in mortality, fertility, age structure, and composition and explore the relationships between these transitions and the social, or economic, and cultural changes being experienced by diverse societies prior to, during, and following the onset and conclusions of the demographic shifts. Case studies from diverse historical periods and geographic locations are used. Graduate students also meet with the instructor every other week to discuss graduate readings and topics relevant to their papers.

D SOC 463(4630) Islam in Africa and Its Diaspora
For description, see AS&RC 463.

D SOC 481(4810) Global Conflict and Terrorism (SBA) (KCM)
Spring. 3 credits. C. Geisler.
Reviews and discusses issues concerning global development and its relationship to conflict and terrorism. Each class session focuses on a specific topic presented by either a faculty member or a guest speaker leading the discussion and actively engaging the students. The weekly discussion section focuses on discussing in greater depth the reading assignments.

D SOC 494(4800) Special Topics in Development Sociology (SBA)
Fall or spring. 4 credits max. S-U or letter grades.
The department teaches "trial" courses under this number. Offerings vary by semester, and are advertised by the department before the semester starts. Courses offered under the number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

D SOC 497(4901) Independent Study in Development Sociology (SBA)
Fall or spring. 3 credits, variable; may be repeated for credit. Students must register using independent study form (available in 140 Roberts Hall). S-U or letter grades.
Informal study may include a reading course, research experience, or public service experience.

D SOC 560(5600) Analytical Mapping and Spatial Modeling
Fall. 4 credits. J. Francis.
The goal of this course is to introduce students in the social sciences and related fields to geographic information systems and spatial statistics as a set of tools to complement traditional analysis methods. Spatial relationships have become increasingly recognized as important in socioeconomic, political, and demographic

analysis. Recent research in these fields has demonstrated that understanding spatial relationships, in addition to other factors that account for differences and similarities between people and organizations, significantly increase our explanatory power. The first part of the course focuses on various features of GIS that are most useful to social scientists in their endeavors. The second part of the course introduces spatial statistics that further this understanding as well as control for spatial autocorrelation when it exists.

D SOC 603(6030) Classical Sociological Theory
Fall. 4 credits. Prerequisite: graduate standing. M. J. Pfeffer.
Reviews the main streams of classical sociological thought, focusing on the work of Weber, Durkheim, Marx, and Simmel. Course materials include original texts and secondary literature used to examine the concepts, methods, and explanation in classical sociological thought. Important objectives are to identify the philosophical and conceptual core of the discipline and to critically evaluate the relevance of the classical theories to contemporary social change and development.

D SOC 606(6060) Sociological Theories of Development
Spring. 3 credits. Prerequisite: D SOC 603 or permission of instructor. F. Makki.
Critical examination of a historical range of theories and research in the sociology of development from the postwar period through the present. Major topics include modernization theory, dependency theory, world-system theory, the developmental state, global commodity chains, and globalization. Throughout the course, the concept of development itself is questioned and critiqued both theoretically and in terms of practical challenges from environmental, indigenous, and other social movements.

D SOC 608(6080) Demographic Techniques (also PAM 606[6060])
Spring. 3 credits. Prerequisite: multivariate statistics or permission of instructor. S-U or letter grades. K. Joyner.
Introduction to the methods, measures, and data used in the analysis of human populations. Topics include demographic rates, life-table analysis, cohort vs. period analysis, sources and quality of demographic data, population estimation and projection, and stable population models.

D SOC 612(6120) Population and Development in Asia
Spring. 3 credits. Prerequisite: graduate standing. L. Williams.
This graduate course considers issues surrounding population growth and distribution, and economic development in Asia. Case studies pertaining to Southeast Asia are highlighted. Specific topics include shifting fertility patterns with social change, labor migration patterns within and between countries, and gender differences in mortality over the life course. Evolving gender roles in the family, labor force, and broader social context are also examined.

D SOC 615(6150) Qualitative Research Methods
Fall. 3 credits. Letter grades only. L. Williams.
Seminar introducing students to a number of qualitative research methods in the social sciences. Discusses field observation, archival research, in-depth individual interviews, and focus group interviews. Assesses the strengths and weaknesses of various strategies of field research and consider a range of practical matters such as choice of research site (and sample where appropriate). We discuss choice of research questions and issues of feasibility in research plans. Highlights ethical considerations.

D SOC 617(6170) Foundations in Social Research: Comparative Epistemologies
Fall. 3 credits. Letter grades only. S. Feldman.
Seminar designed to introduce graduate students in the social sciences to the variety of epistemological approaches used by social scientists to analyze social change and development. Examines both positivist and nonpositivist approaches. Relates the relationship of quantitative and qualitative methodologies to different epistemologies.

D SOC 619(6190) Quantitative Research Methods
Spring. 4 credits. Prerequisite: statistics course. Letter grades only. D. Gurak.
Graduate-level course in measurement and analysis of survey, demographic, and observational data. Topics include linear regression, analysis of variance, and analysis of covariance with both continuous and categorically coded variables. Introduces logistic regression and some nonlinear models. Gives special attention to handling ordered and unordered categorical data as these are prevalent in social/demographic data sets. Analyzes data from real surveys like the American National Election Studies and the General Social Surveys using programs like SAS and SPSS. Includes labs and writing programs to analyze these data. Students familiarize themselves with data cleaning, missing data estimation, transformations, subsetting, and other data handling procedures.

D SOC 621(6210) Foundations of Environmental Sociology
Spring. 3 credits. Prerequisite: graduate standing. C. Geisler.
Foundations of environmental sociology provide graduate students with a broad survey of the literature in this disciplinary specialty area. Students review the history of thought in environmental sociology as well as key literature in the various substantive foci of this specialty. The principle objective of this course is to provide graduate students specializing in environmental sociology with a firm grasp of the content, controversies, and trends in the area. Sessions are conducted in a seminar style, and discussions are focused on close review of assigned readings.

D SOC 629(6300) Human Migration: Internal and International
Prerequisite: graduate standing.
For description, see D SOC 430.

D SOC 632(6320) Environmental Governance
For description, see NTRES 331.

D SOC 638(6380) Population and Development
For description, see D SOC 438.

D SOC 663(6630) Islam in Africa and Its Diaspora
For description, see AS&RC 463.

D SOC 694(6800) Special Topics in Development Sociology
Fall or spring. 4 credits max. Prerequisite: graduate standing. S-U or letter grades.
The department teaches "trial" courses under this number. Offerings vary by semester, and are advertised by the department before the semester starts. Courses offered under the number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

D SOC 719(7190) Logistic Regression and Spatial Linear Regression
Spring. 4 credits. J. D. Francis.
This course will cover two topics, logistic regression and spatial linear regression. The course opens with a brief review of multiple regression theory and procedures. Then a little more than half the semester is devoted to logistic regression modeling. Spatial linear regression will be covered in five weeks of the semester. As both of these techniques are based on maximum likelihood procedures, some time will be devoted to an overview of maximum likelihood procedures.

D SOC 791(7910) Teaching Experience
Fall or spring. 1–3 credits. Prerequisite: D SOC graduate standing. S-U grades only. Graduate faculty.
Participation in the ongoing teaching program of the department.

D SOC 800(8900) Master's-Level Thesis Research
Fall or spring. Credit TBA. Prerequisite: permission of instructor. S-U or letter grades. Graduate faculty.
Thesis research for master's students.

D SOC 872(8720) Development Sociology
Prerequisite: master's and doctoral degree candidates, permission of graduate field member concerned. S-U or letter grades. Graduate faculty.

D SOC 900(7900) Graduate-Level Thesis Research
Fall or spring. Credit TBA. Prerequisite: D SOC graduate standing and permission of instructor. S-U or letter grades. Graduate faculty.
Thesis research for Ph.D. students *only before* "A" exam has been passed.

D SOC 901(9900) Doctoral-Level Thesis Research
Fall or spring. Credit TBA. Prerequisite: D SOC graduate standing and permission of instructor. S-U or letter grades. Graduate faculty.
Thesis research for Ph.D. candidates *after* "A" exam has been passed.

Related Courses in Other Departments

(Others may be added)

Population Dynamics (SOC 205)

Gender Relations, Gender Ideologies, and Social Change (FGSS 524)

EARTH AND ATMOSPHERIC SCIENCES

T. E. Jordan, chair (2116 Snee Hall, 255-3596; 254-8737); S. J. Colucci, co-chair; director of undergraduate studies: B. L. Isacks (Science of Earth Systems); M. W. Wysocki (Atmospheric Science), R. W. Allmendinger, W. D. Allmon, C. Andronicos, M. Barazangi, L. D. Brown, L. M. Cathles, J. L. Cisne, K. H. Cook, A. T. DeGaetano, L. A. Derry, P. J. Gierasch, M. Goman, C. H. Greene, D. L. Hysell, B. L. Isacks, R. W. Kay, S. Mahlburg Kay, M. C. Kelley, R. Lohman, N. Mahowald, B. Monger, A. Moore, J. Phipps Morgan, M. Pritchard, S. J. Riha, E. K. Vizy, W. M. White, D. S. Wilks

General Courses

EAS 121(1121) Introduction to MATLAB (also CIS 121[1121])
Fall, spring. 2 credits. Corequisite: MATH 111, 191, or equivalent. No programming experience assumed. Staff.
For description, see CIS 121.

EAS 150(1500) FORTRAN Applications in Earth Science
Spring, seven-week course. 2 credits. Prerequisite: CIS/EAS 121 or equivalent. Letter grades only. A. M. W. Wysocki.
Emphasizes the application of scientific computing in the Earth sciences, including data processing and modeling of the Earth, its atmosphere, and oceans. Extends the procedural programming concepts developed in CIS 121/EAS 121 and considers their implementation in high-performance, compiled languages. Topics include the structure and syntax of a FORTRAN program, data input/output, compilation, and debugging.

EAS 496(4960) Internship Experience
Fall or spring. 1–2 credits. S-U grades only. Staff. See individual units for requirements.

EAS 498(4980) Teaching Experience in Earth and Atmospheric Sciences
Fall, spring. 1–4 credits. S-U grades only. Students must register using independent study form. Staff.
The student assists in teaching an EAS course appropriate to his or her previous training. The student meets with a discussion or laboratory section, prepares course materials, grades assignments, and regularly discusses course objectives and teaching techniques with the faculty member in charge of the course.

Atmospheric Science

EAS 131(1310) Basic Principles of Meteorology
Fall. 3 credits. M. W. Wysocki.
Simplified treatment of the structure of the atmosphere: heat balance of the Earth; general and secondary circulations; air masses, fronts, and cyclones; and hurricanes, thunderstorms, tornadoes, and atmospheric condensation. The optional 1-credit laboratory for the course is offered as EAS 133.

EAS 133(1330) Basic Meteorology Lab
Fall. 1 credit. Corequisite: EAS 131. M. W. Wysocki.
This course is required for atmospheric science majors but is optional for other students taking EAS 131.

EAS 250(2500) Meteorological Observations and Instruments
Fall. 4 credits. Prerequisite: EAS 131. M. W. Wysocki and B. Monger.
Covers methods and principles of meteorological measurements and observations including surface, free-air, and remote systems. Also covers instrument siting, mounting, and protection; instrument response characteristics, calibration, and standardization; and recorders and data logging systems. Laboratory exercises are in observation and data analysis. The course is intended to serve as preparation for Observers Examination.

EAS 268(2680) Climate and Global Warming
Spring. 3 credits. Prerequisite: basic college math. S-U or letter grades. A. T. DeGaetano.
Familiarizes students from a range of disciplines with such contemporary issues in climatology as global warming and El Niño. Introduces the natural greenhouse effect, past climates, and observed and projected climate changes and impacts. Also covers natural climate variations (e.g., El Niño) and their consequences and predictability. Readings focus on recent scientific findings related to climate change.

EAS 296(2960) Forecast Competition
Fall and spring. 1 credit; students enroll for two consecutive semesters; credit awarded after second semester; may be repeated for credit. Prerequisite: sophomore standing in atmospheric science or permission of instructor. S-U grades only. D. S. Wilks.
Two-semester course providing daily exercise in probabilistic weather forecasting, in which students compete to forecast local weather most skillfully.

EAS 305(3050) Climate Dynamics
Fall. 3 credits. Prerequisites: two semesters of calculus and one semester of physics. K. H. Cook.
Discusses processes that determine climate and contribute to its change, including atmospheric radiation, ocean circulation, and atmospheric dynamics. Investigates contemporary climate change issues and discusses them in the context of natural variability of the system.

EAS 334(3340) Microclimatology
Spring. 3 credits. Prerequisite: physics course. D. S. Wilks.
The relationship of radiant energy, temperature, wind, and moisture in the atmosphere near the ground. The interplay between physical processes of the atmosphere, plant canopies, and soil is examined with emphasis on the energy balance.

EAS 341(3410) Atmospheric Thermodynamics and Hydrostatics
Fall. 3 credits. Prerequisites: one year of calculus and one semester of physics. M. W. Wysocki.
Introduction to the thermodynamics and hydrostatics of the atmosphere and to the methods of description and quantitative analysis used in meteorology. Topics include thermodynamic processes of dry air, water vapor, and moist air, and concepts of hydrostatics and stability.

EAS 342(3420) Atmospheric Dynamics (also ASTRO 342[3342])
Spring. 3 credits. Prerequisites: MATH 192, 213, or equivalent; one year of physics. K. H. Cook.
Introduction to the basic equations and techniques used to understand motion in the atmosphere, with an emphasis on the space and time scales typical of storm systems (the synoptic scale). Derives the governing equations of atmospheric flow from first principles and applies them to middle latitude and tropical meteorology. Topics include balanced flow, atmospheric waves, circulation, and vorticity.

EAS 352(3520) Synoptic Meteorology I
Spring. 3 credits. Prerequisite: EAS 341. Corequisite: EAS 342. M. W. Wysocki.
Study of weather map analysis and forecasting techniques by applying the principles of fluid and heat flow. Strengthens previously introduced meteorological concepts that are applied to forecasting midlatitude synoptic scale weather systems, such as cyclones, anticyclones, jet streams, fronts, and waves.

EAS 435(4350) Statistical Methods in Meteorology and Climatology
Fall. 3 credits. Prerequisites: one introductory course each in statistics (e.g., AEM 210) and calculus. D. S. Wilks.
Statistical methods used in climatology, operational weather forecasting, and selected meteorological research applications. Includes statistical characteristics of meteorological data including probability distributions and correlation structures. Covers operational forecasts derived from multiple regression models, including the MOS system and forecast evaluation techniques.

EAS 447(4470) Physical Meteorology
Fall. 3 credits. Prerequisites: one year each of calculus and physics. A. T. DeGaetano.
Primarily a survey of natural phenomena of the atmosphere, with emphasis on their underlying physical principles. Topics include an introduction to atmospheric radiation processes; atmospheric optics and electricity; microphysical cloud processes; and principles of radar probing of the atmosphere.

EAS 451(4510) Synoptic Meteorology II
Fall. 3 credits. Prerequisites: EAS 341 and 342. E. K. Vizy.
Structure and dynamics of large-scale midlatitude weather systems, such as cyclones, anticyclones, and waves, with consideration of processes that contribute to temperature changes and precipitation. Lab sessions involve real-time weather forecasting and the computer application of a numerical model of the atmosphere to study selected large-scale midlatitude weather events.

EAS 456(4560) Mesoscale Meteorology
Spring. 3 credits. Prerequisites: EAS 341 and 342 or permission of instructor. S. J. Colucci.
Structure and dynamics of midlatitude mesoscale weather systems such as fronts, jets, squall lines, convective complexes, precipitation bands, downslope windstorms, mountain breezes, seas breeze circulations, and lake effect snowstorms. The course also considers tropical weather systems and mesoscale modeling.

[EAS 457(4570) Atmospheric Air Pollution
Fall. 3 credits. Prerequisites: EAS 341 or one course in thermodynamics, and one semester of chemistry, or permission of instructor. Next offered 2008–2009. M. W. Wysocki.]

EAS 470(4700) Weather Forecasting and Analysis
Spring. 3 credits. Prerequisites: EAS 352 and 451. M. W. Wysocki.
Applied course focusing on weather forecasting and analysis techniques for various regions around the world. Lectures emphasize the application of student's knowledge of atmospheric dynamics, thermodynamics, and computer data analysis, to forecast the development and movement of multiscale weather systems. Students participate in weekly forecast discussions; write daily forecasts that include a synoptic discussion, quantitative precipitation forecasts, and severe weather outlook for the forecast region; and lead class discussion on assigned readings.

EAS 483(4830) Environmental Biophysics (also CSS 483[4830])
Spring. 3 credits. Prerequisite: CSS 260 or equivalent or permission of instructor. S. J. Riha.
Introduction to basic principles of energy and mass transfer and storage in soil-plant systems. Covers energy budgets; soil heat flow; water movement in saturated and unsaturated soils; evapotranspiration; and water, gas, and nutrient dynamics in the soil-plant-atmosphere continuum. Considers applications to agronomic and environmental problems and instrument design and use through discussion and problem sets.

EAS 484(4840) Inverse Methods in the Natural Sciences
Spring. 3 credits. Prerequisites: MATH 294. D. L. Hysell.
An exploration of solution methods for inverse problems with examples taken from geophysics and related fields, with particular attention to making inferences from inaccurate, incomplete, or inconsistent physical data. Applications include medical and seismic tomography, earthquake location, image processing, and radio/radar imaging. Linear algebra (including condition numbers) and probability and statistics (including error analysis, Bayes theorem, Gibbs distribution, and Markov chains) will be reviewed. Methods to be covered include nonlinear least-squares, maximum likelihood methods, and local and global optimization methods, including simulated annealing and genetic algorithms.

EAS 487(4870) Introduction to Radar Remote Sensing (also ECE 487[4870])
Fall. 3 credits. Prerequisite: PHYS 208 or 213 or equivalent, or permission of instructor. D. L. Hysell.
Fundamentals of radar, antennas, and remote sensing. Exposes students to the principles underlying the analysis and design of antennas used for communication and for radar-related applications. Students also encounter both a mathematical and a practical description of how radars function, how their performance can be optimized for different applications, and how signals acquired by them can be processed. The objective is to familiarize students with a wide variety of radars rather than to turn them into practicing radar engineers. Each topic is developed from basic principles so students with a wide variety of backgrounds are able to take the course. Emphasizes radar applications in geophysics, meteorology and atmospheric sciences, and astronomy and space sciences. Gives special attention to radar remote sensing of the Earth from spacecraft.

EAS 494(4940) Special Topics in Atmospheric Science (undergraduate level)
Fall or spring. 8 credits max. S-U or letter grades. Staff.
The department teaches "trial" courses under this number. Offerings vary by semester and are advertised by the department before the semester starts. The same course is not offered more than twice.

EAS 497(4970) Individual Study in Atmospheric Science
Fall or spring. 1–6 credits. S-U grades only. Students must register using independent study form. Staff.
Topics are arranged at the beginning of the semester for individual study or for group discussions.

EAS 499(4990) Undergraduate Research in Atmospheric Science
Fall or spring. Credit TBA. S-U grades only. Students must register using independent study form. Staff.
Independent research on current problems in atmospheric science.

EAS 542(5420) Numerical Methods in Atmospheric Modeling
Spring. 3 credits. Prerequisite: partial differential equations and introductory numerical methods or permission of instructor. S-U or letter grades. N. Mahowald.
Climate and numerical weather prediction models are important tools for policy and science. This course describes the basic principles of the numerics in these models, including finite difference, spectral methods, and subgrid parameterizations. Included will be a discussion of numerical stability and verification of models.

EAS 584(5840) Inverse Methods in the Natural Sciences
Spring. 3 credits. Prerequisite: MATH 294. D. L. Hysell.
An exploration of solution methods for inverse problems with examples taken from geophysics and related fields, with particular attention to making inferences from inaccurate, incomplete, or inconsistent physical data. Applications include medical and seismic tomography, earthquake location, image processing, and radio/radar imaging. Linear algebra (including condition numbers) and probability and statistics (including error analysis, Bayes theorem, Gibbs distribution, and Markov chains) will be reviewed. Methods to be covered include nonlinear least-squares, maximum likelihood methods, and local and global optimization methods, including simulated annealing and genetic algorithms. Students in EAS 584 will be expected to complete and present a substantial class project to be negotiated with the instructor.

EAS 648(6480) Air Quality and Atmospheric Chemistry (also M&AE 6480)
Fall. 3 credits. Prerequisites: freshmen chemistry, fluid mechanics or equivalent, thermodynamics. S-U or letter grades. K. M. Zhang.
Factors determining air quality and effects of air pollutants on public health, ecological systems and global climate change.

[EAS 652(6520) Advanced Atmospheric Dynamics (also ASTRO 652[7652])
Spring. 3 credits. Prerequisites: EAS 341 and 342 or equivalents. Next offered 2008–2009. S. J. Colucci.]

[EAS 666(6660) Applied Multivariate Statistics
Spring. 3 credits. Prerequisites: multivariable calculus, matrix algebra, two statistics courses. Next offered 2008–2009. D. S. Wilks.]

[EAS 675(6750) Modeling the Soil-Plant-Atmosphere System (also CSS 675[6750])
Spring. 3 credits. Prerequisite: EAS/CSS 483 or equivalent. Next offered 2008–2009. S. J. Riha.]

EAS 692(6920) Special Topics in Atmospheric Science
Fall or spring. 1–6 credits. S-U or letter grades. Staff.
Study of topics in atmospheric science that are more specialized or different from other courses. Special topics covered depend on staff and student interests.

EAS 711(7110) Upper Atmospheric and Space Physics
Fall or spring. 1–6 credits. Seminar course. D. L. Hysell.

EAS 850(8500) Master's-Level Thesis Research in Atmospheric Science
Fall or spring. Credit TBA. S-U grades only. Graduate faculty.
Thesis research for atmospheric science master's students.

EAS 950(9500) Graduate-Level Dissertation Research in Atmospheric Science
Fall or spring. Credit TBA. S-U or letter grades. Graduate faculty.
Dissertation research for atmospheric science Ph.D. students only *before* "A" exam has been passed.

EAS 951(9510) Doctoral-Level Dissertation Research in Atmospheric Science
Fall or spring. Credit TBA. S-U or letter grades. Graduate faculty.
Dissertation research for atmospheric science Ph.D. candidates *after* "A" exam has been passed.

Science of Earth Systems

Field Study in Hawaii

Field study is a fundamental aspect of earth system science. Students wishing to increase their field experience may fulfill some of the requirements for the SES major by off-campus study through the Cornell Earth and Environmental Semester program (EES). The EES program is offered during the spring semester and emphasizes field-based education and research. It is based on the island of Hawaii, an outstanding natural

laboratory for earth and environmental sciences. Courses that may be applied to the SES major include EAS 240, 322, and 351. The EES program also offers opportunities for internships with various academic, nonprofit, and government organizations. Typically students participate in the EES program during their junior year, although exceptions are possible. For further information on the EES program see www.geo.cornell.edu/geology/classes/hawaii/course.html.

EAS 101(1101) Introductory Geological Sciences (To Know Earth)
Fall. 3 credits. C. Andronicos.
Designed to enhance an appreciation of the physical world for nonscientists and science majors. Emphasizes natural environments, surface temperatures, dynamic processes such as mountain belts, volcanoes, earthquakes, glaciers, and river systems. Covers interactions of the atmosphere, hydrosphere, biosphere, and lithosphere (Earth system science). Examines water, mineral, and fuel resources and environmental concerns.

EAS 108(1108) Earth in the News
Summer. 3 credits. S. L. Losh.
Introduction to physical geology and Earth system science and explores the scientific basis for informed decision making regarding many timely environmental issues including global warming; water pollution and use; geologic hazards such as floods, earthquakes, and volcanoes; fossil fuel distribution and use; and land use. A field trip is taken in the Ithaca area.

EAS 109(1109) Dinosaurs
Fall. 1 credit. J. L. Cisne.
Introductory survey course for anyone interested in dinosaurs. Lectures examine the fossil evidence and illustrate how various geological and biological disciplines contribute to understanding dinosaurs and their world.

EAS 119(1190) Fossil Preparation
Fall, 1 credit. Prerequisite: EAS 109 or related EAS course. W. Allmon and J. Cisne.
Hands-on experience in the preparation and curation of fossils in laboratories at the Paleontological Research Institution (PRI). Students provide own transportation to the Museum of the Earth via public transit or other means. Activities include preparation and study of vertebrate, invertebrate, and plant specimens; sorting of bulk material such as field collections and mastodon dung, and curation of prepared specimens.

EAS 122(1220) Earthquake! (also ENGRI 122[1120])
Spring. 3 credits. L. Brown.
Explores the science of natural hazards and strategic resource. Covers techniques for locating and characterizing earthquakes and assessing the damage they cause; methods of using sound waves to image the Earth's interior to search for strategic minerals; and the historical importance of such resources. Includes seismic experiments on campus to probe for groundwater, the new critical environmental resource.

EAS 154(1540) Introductory Oceanography—Lecture (also BIOEE 154[1540])
Fall, summer. 3 credits; optional 1-credit lab offered as EAS/BIOEE 155. S-U or letter grades. Spring: B. C. Monger and C. H. Greene; summer: B. C. Monger.
Intended for both science and nonscience majors. Cover the basic workings of the ocean including its physics, chemistry, and biology. Following this basic description, the course examines threats to the health of the ocean and the important role the ocean plays in global climate change. Nonscience majors should pay particular attention to this course to fulfill a science requirement, because they learn broadly how the Earth works (physically, chemically, and biologically) in a single nonquantitative class.

EAS 155(1550) Introductory Oceanography—Laboratory (also BIOEE 155[1550])
Fall. 1 credit. Corequisite: EAS/BIOEE 154. B. C. Monger and C. H. Greene.
Laboratory course covering topics presented in EAS/BIOEE 154.

EAS 170(1700) Evolution of the Earth and Life (also BIO G 170[1700])
Spring. 3 credits. J. L. Cisne.
Earth systems and their evolution; Earth history's astronomical context; plate tectonics, continental drift, and their implications for climate and life; coevolution of life and the atmosphere; precedents for ongoing global change; dinosaurs, mass extinctions, and human ancestry. Includes laboratories on reconstructing geological history and mapping ancient geography. Fossil-collecting on field trips.

EAS 213(2130) Marine and Coastal Geology
Summer. 4 credits. Prerequisite: introductory geology or ecology course or permission of instructor. Staff.
Special two-week course offered at Cornell's Shoals Marine Laboratory (SML), located on an island near Portsmouth, N.H. For more details, including estimated cost and an application, contact SML office, G14 Stimson Hall, or visit www.sml.cornell.edu.

EAS 220(2200) The Earth System
Fall, spring. 4 credits. Prerequisites: MATH 111/191. Letter grades only. Staff.
An integrated introduction to the earth system stressing the biological, chemical, geological, and physical interactions among the atmosphere, ocean, and solid earth. Topics covered will include biogeochemical cycles, climate dynamics, and the evolution of the atmosphere, biosphere, cryosphere (ice), hydrosphere (oceans and inland waters), and lithosphere (solid earth).

EAS 222(2220) Seminar: Hawaii's Environment
Fall. 1 credit. S-U grades only. A. Moore.
A seminar for students interested in the unique environmental systems of the Hawaiian Islands. This course is designed to bring together students returning from field studies in Hawaii with students interested in going there to study. Through reading and discussion we will explore the geology, biology, ocean, atmosphere, and culture of the Hawaiian environment.

EAS 240(2400) Field Study of the Earth System
Spring. 5 credits. Prerequisites: enrollment in EES Semester in Hawaii, one semester of calculus (MATH 190/191/192 or 111/112) and two semesters of any of the following: PHYS 207/208 or 112/213; CHEM 207/208; BIO G 101/103–102/104 or 105/106 or 109/110 or equivalent course work. A. Moore.
Interdisciplinary field course covering fundamental concepts of the Earth system. Topics include global circulation patterns in the solid Earth, atmosphere and ocean; energy and mass transfer; change and variability of Earth atmosphere and ocean systems; the temporal record of change preserved in the geologic record; Earth/ocean/atmospheric controls on ecosystem processes. The course is project-based with students engaged in hands-on, active learning that takes advantage of local resources.

EAS 301(3010) Evolution of the Earth System
Fall. 4 credits. Prerequisites: MATH 112 or 192 and CHEM 207 or equivalent. T. Jordan, S. Riha, and W. Allmon.
Life activities alter the physical and chemical environment, and are altered by that environment. This interaction over very long times constitutes a co-evolution of earth and life. Course uses modern systems, tens of thousand year old systems, and hundreds of million year old systems to illustrate principles, methods of reconstructing deep history, and the context of natural change inherent to life and earth.

EAS 303(3030) Introduction to Biogeochemistry (also NTRES 303[3030])
Fall. 4 credits. Prerequisites: CHEM 207, MATH 112, and biology and/or geology course. L. A. Derry and J. Yavitt.
Control and function of the Earth's global biogeochemical cycles. Begins with a review of the basic inorganic and organic chemistry of biologically significant elements, and then considers the biogeochemical cycling of carbon, nutrients, and metals that take place in soil, sediments, rivers, and the oceans. Topics include weathering, acid-base chemistry, biological redox processes, nutrient cycling, trace gas fluxes, bio-active metals, the use of isotopic tracers, controls on atmospheric carbon dioxide, and mathematical models. Interactions between global biogeochemical cycles and other components of the Earth system are discussed.

EAS 304(3040) Interior of the Earth
Spring. 3 credits. Prerequisite: EAS 220 or permission of instructor. C. Andronicos.
This class will investigate the geology of the solid earth with emphasis on igneous and metamorphic petrology, structure of the continents and ocean basins, and large scale tectonics. Interaction between deformation, melt generation and metamorphism will be examined as mechanisms by which the crust is differentiated from the underlying mantle. Geophysical and geochemical techniques for probing the deep interior of the earth will be investigated. Plate tectonics will be used as a unifying theme to understand processes operating in the solid earth.

EAS 322(3220) Biogeochemistry of the Hawaiian Islands
Spring. 4 credits. Prerequisites: enrollment in EES semester in Hawaii; EAS 220, EAS 303. L. Derry.
Field-oriented study of biogeochemical processes and ecosystem interactions across the Hawaiian Islands. Field, class, and laboratory work focus on how landscape age and climate strongly control biogeochemical cycling and ecosystem development in Hawaii. Other topics include succession of ecosystems, evolution of nutrient cycles, and impacts of invasive species. The course is structured around field projects, carried out both as groups and individually.

EAS 350(3500) Dynamics of Marine Ecosystems (also BIOEE 350[3500])
Fall. 3 credits. Prerequisites: one year of calculus and one semester of oceanography (i.e., BIOEE/EAS 154) or permission of instructor. Alternate years. C. H. Greene and R. W. Howarth.
Lecture course covering the interactions of physical and biological processes in marine ecosystems. Begins by looking at these processes on a global scale and works down to the scales relevant to individual organisms. Topics include global patterns of ocean circulation; global patterns of ocean production; climate variability and the role of the ocean in global climate change; the El Niño/Southern Oscillation; ecosystem dynamics of the open ocean and coastal environments.

EAS 351(3510) Marine Ecosystems Field Course (also BIOEE 351[3510])
Spring. 4 credits. Prerequisite: EAS 240. Recommended: oceanography course. C. Greene, B. Monger, and C. D. Harvell.
Covers the interactions of physical and biological processes in marine ecosystems. Begins by looking at these processes on ocean-basin to regional scales and work down to the smaller scales relevant to individual organisms. Introduces students to modern techniques of marine-ecosystems research, including remote sensing, oceanographic-survey methods, and experimental marine ecology. This course is field and laboratory intensive with students engaged in hands-on, active learning that takes advantage of local resources.

[EAS 353(3530) Physical Oceanography
Fall. 3 credits. Prerequisites: MATH 112 or 192, or one year of physics, or permission of instructor. Offered alternate years; next offered 2008–2009. B. C. Monger.]

EAS 401(4010) Fundamentals of Energy and Mineral Resources
Fall. 3 credits. Prerequisites: Introductory college level geology, physics and chemistry, and math through differential equations or permission of instructor. L. Cathles.
The earth's energy and mineral resources reflect some of the most important changes and dramatic events that have punctuated earth history. Course provides an overview of resource types in the context of the earth's atmospheric evolution, rifting, mantle convection, and hydrologic cycle. The processes of resource accumulation are described in terms of simple, fundamental chemical and physical principles.

[EAS 404(4040) Geodynamics
Spring. 3 credits. Prerequisite: calculus and calculus-based physics courses or permission of instructor. Offered alternate years; next offered 2008–2009. J. Phipps Morgan.]

EAS 405(4050) Active Tectonics
Spring. 3 credits. Recommended: mechanical background equivalent to EAS 426/488. Offered alternate years. R. Lohman.
Develops the ideas and methods necessary to understand how the Earth deforms—from individual earthquakes to the construction of mountain ranges. Discusses the driving forces of deformation, and how these forces interact with different geologic materials to cause deformation.

EAS 415(4150) Geomorphology
Fall. 3 credits. B. L. Isacks.
A study of terrestrial landscapes as constructed by Earth's internal tectonic processes and modified by climate. Laboratory exercises include computer analyses of satellite images and digital elevation models and student reviews of papers from the rapidly growing literature on a key focus of modern geomorphology, the interactions of tectonics and climate.

EAS 417(4170) Field Mapping in Argentina
Summer. 3 credits. Prerequisite: introductory EAS course and EAS 426 or EAS 304. S. Mahlburg Kay.
Field mapping course in Argentina that fulfills field requirement for majors with interests in geological sciences and provides a field geological experience for others. Course consists of lectures in Buenos Aires followed by field exercises in the Sierras Pampeanas, Precordillera, and Main Cordillera Ranges of the Argentine Andes in the provinces of San Juan and Mendoza. A variety of exercises use modern techniques in the field mapping of a broad range of variably deformed sedimentary, metamorphic and igneous rocks. The course further provides an introduction to the tectonics and magmatic processes of the central Andes with emphasis on comparable processes in the U.S. Exercises are done in combination with students and faculty of the University of Buenos Aries.

[EAS 425(4250) European Discovery of Impacts and Explosive Volcanism
Spring. 2 credits. Prerequisites: junior, senior, or graduate students with a background in geology and permission of instructor. One two-hour meeting per week plus field trip during spring break. Offered alternate years, next offered 2008–2009. J. Phipps Morgan.]

EAS 426(4260) Structural Geology
Spring. 4 credits. Prerequisite: one semester of calculus plus introductory geology course, or permission of instructor. One weekend field trip. Offered alternate years. R. W. Allmendinger.
The nature and origin of deformed rocks at submicroscopic to global scales. The course begins with a review of elementary principles of continuum mechanics and continues with a discussion of deformation mechanisms commonly observed in earth materials. The geometry, kinematics, and mechanics of faults, folds, are then addressed and the class ends with a description of the tectonic setting of structural families such as thrust belts, rift provinces, and zones of strike slip deformation. A weekend field trip to a region of spectacular folding and thrusting provides and opportunity to apply the concepts learned in lecture.

[EAS 434(4340) Exploration Geophysics
Fall. 3 credits. Prerequisites: MATH 192 and PHYS 208, 213, or equivalent. Offered alternate years; next offered 2008–2009. L. D. Brown.]

EAS 437(4370) Geophysical Field Methods (also ARKEO 437[4370])
Fall. 3 credits. Prerequisites: PHYS 213 or 208, or permission of instructor. Offered alternate years. L. D. Brown.
Introduction to field methods of geophysical exploration, especially as applied to environmental issues. Emphasizes seismic, ground penetrating radar, gravity, and magnetic techniques. Analyzes and interprets field surveys carried out at the beginning of the semester.

EAS 440(4400) Seminar on the Intergovernmental Panel on Climate Change Report
Fall. 2 credits. Prerequisites: senior or higher standing. Offered alternate years. N. Mahowald.
The IPCC report has already received substantial public attention, and it will impact environmental and economic decisions for years to come. The course will focus on reading, understanding, and evaluating the IPCC report (2007 version). Students will lead a discussion, write a term paper on one or more chapters of the report, and participate in discussions led by other students.

EAS 453(4530) Mineralogy
Fall. 4 credits. Prerequisite: EAS 101 or 220 and CHEM 207 or permission of instructor. S. Mahlburg Kay.
Chemical and physical properties and identification of minerals with emphasis on the rock-forming minerals that are the principal constituents of the Earth and nearby planets. Topics include internal and external crystallography, crystal chemistry, introductions to x-ray crystallography and optical mineralogy, and a systematic examination of the structures, chemistry, and occurrence of the rock-forming minerals. Independent project includes use of electron microprobe (EPMA) and x-ray facilities.

[EAS 454(4540) Petrology and Geochemistry
Spring. 4 credits. Prerequisite: EAS 453. Offered alternate years; next offered 2008–2009. R. W. Kay.]

EAS 455(4550) Geochemistry
Fall. 4 credits. Prerequisites: CHEM 207 and MATH 192 or equivalent. Recommended: EAS 304. Offered alternate years. W. M. White.
The Earth from a chemical perspective. Covers the formation of the elements; cosmochemistry; chemical evidence regarding the formation of the Earth and solar system; trace-element geochemistry; isotope geochemistry; geochemical thermodynamics and kinetics; chemical evolution of the crust, mantle, and core; weathering and the chemistry of natural waters; chemistry of rivers and the oceans; hydrothermal systems; and ore deposition.

[EAS 458(4580) Volcanology
Fall. 3 credits. Prerequisite: EAS 304 or equivalent. Offered alternate years; next offered 2008–2009. R. W. Kay.]

[EAS 460(4600) Late Quaternary Paleoecology
Fall. 4 credits. Offered alternate years; next offered 2008–2009. M. Goman.]

EAS 461(4610) Paleoclimate: Since the Last Ice Age
Fall. 3 credits. Prerequisites: EAS 220 or permission of instructor. Offered alternate years. M. Goman.
Climate change is becoming increasingly important in the 21st century. In order to understand modern climate change it is helpful to understand past climate changes and variability. This course examines changes and variability in climate for the last 21,000 years. It will focus on the causes, extent, and evidence for climate change. Material covered will include evidence for orbital scale climate change, millennial and decadal scale changes, as well as extreme climate events and historic scale changes recorded in the terrestrial, ice, and oceanic records.

[EAS 462(4620) Marine Ecology (also BIOEE 462[4620])
Fall. 3 credits. Limited to 75 students. Prerequisite: BIOEE 261. Offered alternate years; next offered 2008–2009. C. D. Harvell and C. H. Greene.
For description, see BIOEE 462.]

EAS 471(4710) Introduction to Groundwater Hydrology (also BEE 471[4710])
Spring. 3 credits. Prerequisite: MATH 293, fluid mechanics or hydrology course. Offered alternate years. T. S. Steenhuis and L. M. Cathles.
Intermediate-level study of aquifer geology, groundwater flow, and contamination of aquifers and clean-up methods. Includes description of transport of pesticides, nutrients, and toxics through the unsaturated zone and aquifers. Discusses theoretical and practical applications. Includes short field trips.

EAS 475(4750) Special Topics in Oceanography
Fall, spring, summer. 2–6 credits, variable. Prerequisites: one semester of oceanography and permission of instructor. Fall, spring: C. H. Greene; summer: B. C. Monger.
Undergraduate instruction and participation in advanced areas of oceanographic research. Topics change from semester to semester. Contact instructor for further information.

EAS 476(4760) Sedimentary Basins
Spring. 3 credits. Prerequisite: EAS 301 or permission of instructor. Offered alternate years. T. Jordan.
The focus is on the physical characteristics of sedimentary basins, which host fossil fuels and groundwater, and can potentially store CO2. Topics include lithosphere mechanics and plate tectonic activity that cause subsidence, environments of deposition, and the textures, composition, and architecture of sedimentary rocks. Course objective is to learn to predict properties of rock where they cannot be directly sampled.

[EAS 478(4780) Advanced Stratigraphy
Fall. 3 credits. Prerequisite: EAS 375 or permission of instructor. Offered alternate years; next offered 2008–2009. T. E. Jordan.]

EAS 479(4790) Paleobiology (also BIOEE 479[4790])
Spring. 4 credits. Prerequisites: one year of introductory biology and BIOEE 274 or 373 or EAS 301, or permission of instructor. Offered alternate years. W. D. Allmon.
Surveys the major groups of organisms and their evolutionary histories. Intended to fill out the biological backgrounds of Earth and atmospheric science students concerning the nature and significance of the fossil record for their respective studies.

EAS 481(4810) Senior Survey of Earth Systems
Spring, fall. 2 credits. J. Cisne and R. Kay.
Weekly seminar for seniors in the Science of Earth Systems major on current topics in Earth system science. Readings, presentations, and discussions will focus on results from the recent literature, including how to analyze a scientific paper, and exploration of connections across the subdisciplines in the field. The course will serve as both a review of key concepts, and a vehicle to explore developing concepts in the field.

EAS 484 (4840) Inverse Methods in the Natural Sciences
Spring. 3 credits. Prerequisites: MATH 294. D. L. Hysell.
An exploration of solution methods for inverse problems with examples taken from geophysics and related fields, with particular attention to making inferences from inaccurate, incomplete, or inconsistent physical data. Applications include medical and seismic tomography, earthquake location, image processing, and radio/radar imaging. Linear algebra (including condition numbers) and probability and statistics (including error analysis, Bayes theorem, Gibbs distribution, and Markov chains) will be reviewed. Methods to be covered include nonlinear least-squares, maximum likelihood methods, and local and global optimization methods, including simulated annealing and genetic algorithms.

EAS 487(4870) Introduction to Radar Remote Sensing (also ECE 487[4870])
Fall. 3 credits. Prerequisite: PHYS 208 or 213 or equivalent, or permission of instructor. D. L. Hysell.
Fundamentals of radar, antennas, and remote sensing. Exposes students to the principles underlying the analysis and design of antennas used for communication and for radar-related applications. Students also encounter both a mathematical and a practical description of how radars function, how their performance can be optimized for different applications, and how signals acquired by them can be processed. The objective is to familiarize students with a wide variety of radars rather than to turn them into practicing radar engineers. Each topic is developed from basic principles so students with a wide variety of backgrounds are able to take the course. Emphasizes radar applications in geophysics, meteorology and atmospheric sciences, and astronomy and space sciences. Gives special attention to radar remote sensing of the Earth from spacecraft.

EAS 488(4880) Geophysics and Geotectonics
Spring. 3 credits. Prerequisites: MATH 192 (or 112) and PHYS 208 or 213. Offered alternate years. M. Pritchard.
Covers global tectonics and the deep structure of the solid Earth as revealed by investigations of earthquakes, earthquake waves, the Earth's gravitational and magnetic fields, and heat flow.

EAS 491–492(4910–4920) Undergraduate Research
Fall, spring. 1 to 4 credits. Fill out form at 2124 Snee Hall. Staff (B. L. Isacks, coordinator).
Introduction to the techniques and philosophy of research in geological sciences and an opportunity for undergraduates to participate in current faculty research projects. Topics chosen in consultation with, and guided by, a faculty member. A short written report is required, and outstanding projects are prepared for publication.

EAS 496(4960) Internship Experience
Fall, spring. 2 credits. Prerequisite: EAS 240. S-U grades only. A. Moore.
During the last 3.5 weeks of the semester students carry out a service-learning project with a local NGO, environmental business, government agency, research lab, or educational facility. Projects are carefully designed with the student, sponsoring agency, and faculty member. A final report is required.

EAS 498(4980) Teaching Experience in Earth and Atmospheric Sciences
Fall, spring. 1–4 credits. S-U grades only. Students must register using independent study form. Staff.

[EAS 500(5000) Design Project in Geohydrology
Fall, spring. 3–12 credits. Alternative to industrial project for M.Eng. students choosing geohydrology option. May continue over two or more semesters. Next offered 2008–2009. L. M. Cathles.]

[EAS 502(5020) Case Histories in Groundwater Analysis
Spring. 4 credits. Next offered 2008–2009. L. M. Cathles.]

EAS 505(5050) Fluid Dynamics in the Earth Sciences
Spring. 3 credits. Prerequisites: MATH through 294, PHYS through 208/214 or permission of instructor. L. Cathles and M. Wysocki.
The Earth System provides many fascinating examples of fluid dynamic phenomena that are also of societal importance. Turbulent convection in the outer core generates the earth's magnetic field. The viscous mantle (outer half of the Earth) is slowly but vigorously convecting, and consequently the Earth's surface is dynamic. Viscosity is not important in the oceans and atmosphere, but the flow there is fast enough for the rotation of the Earth to become a dominant control. Electromagnetic effects again dominate in the solar wind and magnetosphere. This course will investigate the Earth using fluid dynamics. For students in the Earth Sciences it will provide an opportunity to learn the insights that can be provided by fluid dynamics. For students who know fluid dynamics from other fields it will provide some spectacular applications and an opportunity to learn about the Earth System in a different and unusually fundamental way.

[EAS 522(5220) Advanced Structural Geology I
Fall. 3 credits. Prerequisites: EAS 426 and permission of instructor. Offered alternate years; next offered 2008–2009. R. W. Allmendinger and C. Andronicos.]

EAS 524(5240) Advanced Structural Geology II
Fall. 3 credits. Prerequisites: EAS 426 and permission of instructor. Offered alternate years. R. W. Allmendinger.
Geometry, kinematics, and mechanics of structural provinces. Concentrates on thrust belts, rift provinces, or strike-slip provinces. Covers techniques of balanced cross sections.

EAS 553(5530) Advanced Petrology
Fall. 3 credits. Prerequisite: EAS 454. Offered alternate years. R. W. Kay.
Magmas and metamorphism in the context of plate tectonics; major and trace element chemistry and phase petrology as monitors of the creation and modification of igneous rocks; temperature and stress in the curst and mantle and their influence on reaction rates and textures of metamorphic rocks; application of experimental studies to natural systems.

[EAS 575(5750) Planetary Atmospheres (also ASTRO 575[6575])
Fall. 4 credits. Prerequisites: undergraduate physics, vector calculus. Offered alternate years; next offered 2008–2009. P. Gierasch.]

[EAS 577(5770) Planetary Surface Processes (also ASTRO 577[6577])
Spring. 3 or 4 credits. Offered alternate years; next offered 2008–2009. J. Bell.]

[EAS 578(5780) Planet Formation and Evolution (also ASTRO 578[6578])
Fall. 4 credits. Prerequisites: familiarity with elementary physics and math or permission of instructor. Offered alternate years; next offered 2008–2009. J-L. Margot and M. Pritchard.
For description, see ASTRO 578.]

EAS 584(5840) Inverse Methods in the Natural Sciences
Spring. 3 credits. Prerequisites: MATH 294. D. L. Hysell.
An exploration of solution methods for inverse problems with examples taken from geophysics and related fields, with particular attention to making inferences from inaccurate, incomplete, or inconsistent physical data. Applications include medical and seismic tomography, earthquake location, image processing, and radio/radar imaging. Linear algebra (including condition numbers) and probability and statistics (including error analysis, Bayes theorem, Gibbs distribution, and Markov chains) will be reviewed. Methods to be covered include nonlinear least-squares, maximum likelihood methods, and local and global optimization methods, including simulated annealing and genetic algorithms. Students in EAS 584 will be expected to complete and present a substantial class project to be negotiated with the instructor.

EAS 628(6280) Geology of Orogenic Belts
Spring. 3 credits. Prerequisite: permission of instructor. S. M. Kay.
Seminar course in which students study specific geologic topics of an orogenic belt selected for study during the semester.

[EAS 641(6410) Analysis of Biogeochemical Systems
Spring. 3 credits. Prerequisite: MATH 293 or permission of instructor. Offered alternate years; next offered 2008–2009. L. A. Derry.]

[EAS 656(6560) Isotope Geochemistry
Spring. 3 credits. Open to undergraduates. Prerequisite: EAS 455 or permission of instructor. Offered alternate years; next offered 2008–2009. W. M. White.]

EAS 693(6930) Special Topics in Geological Sciences
Fall or spring. 1–3 var. credits. S–U or letter grades. Staff.
Study of specialized advanced topics in the Earth Sciences through readings from the scientific literature, seminars, and discussions.

EAS 700–799(7000–7990) Seminars and Special Work
Fall, spring. 1–3 credits. Prerequisite: permission of instructor. Staff.
Advanced work on original investigations in earth and atmospheric sciences. Topics change from semester to semester. Contact appropriate professor for more information.

EAS 722(7220) Advanced Topics in Structural Geology
R. W. Allmendinger.

EAS 731(7310) Advanced Topics in Remote Sensing and Geophysics
M. Pritchard.

EAS 733(7330) Advanced Topics in Geodynamics
Spring. J. Phipps Morgan.

EAS 750(7550) Satellite Remote Sensing in Biological Oceanography
Summer. B. C. Monger

EAS 751(7510) Petrology and Geochemistry
R. W. Kay.

EAS 755(7550) Advanced Topics in Tectonics and Geochemistry
J. Phipps Morgan.

EAS 757(7570) Current Research in Petrology and Geochemistry
S. Mahlburg Kay.

EAS 762(7620) Advanced Topics in Paleobiology
W. D. Allmon.

EAS 771(7710) Advanced Topics in Sedimentology and Stratigraphy
T. E. Jordan.

EAS 773(7730) Paleobiology
J. L. Cisne.

EAS 775(7750) Advanced Topics in Oceanography
C. H. Greene.

EAS 780(7800) Earthquake Record Reading
Fall. M. Barazangi.

EAS 781(7810) Exploration Geophysics
L. D. Brown.

EAS 793(7930) Andes-Himalaya Seminar
S. Mahlburg Kay, R. W. Allmendinger, B. L. Isacks, and T. E. Jordan.

EAS 795(7950) Low Temperature Geochemistry
L. A. Derry.

EAS 796(7960) Geochemistry of the Solid Earth
W. M. White.

EAS 797(7970) Fluid-Rock Interactions
L. M. Cathles.

EAS 799(7990) Soil, Water, and Geology Seminar
Spring. L. M. Cathles and T. S. Steenhuis.

EDUCATION

A. Wilson, chair (435 Kennedy Hall, 255-2207); G. Applebee, R. Caffarella, W. Camp, M. Constas, B. Crawford, B. Heath-Camp, M. Kroma, T. Park, S. Peters, T. Richardson, R. Ripple, V. Rockcastle, D. Schrader, J. Sipple, D. Trumbull, T. Tucker, S. Villenas

EDUC 220(2200) Community Learning and Service Partnership (CLASP)
Fall only. 2 credits. Prerequisite: permission of instructor. Students must commit to taking EDUC 221 the following spring. S-U or letter grades. A. Wilson.
In this service-learning course, students partner with Cornell service staff to accomplish a variety of learning goals selected by the employees. Students are introduced to the field of adult basic education and the principles of the Community Learning and Service Partnership (CLASP). Seminars examine the issues of learning through service and reflection, adult teaching philosophy and practice, and empowerment through education. Students must commit to continuing their service by taking EDUC 221 the following spring semester.

EDUC 221(2210) Community Learning and Service Partnership (CLASP)
Spring only. 2 credits. Prerequisites: EDUC 220 and permission of instructor. S-U or letter grades. A. Wilson.
Continues the field experience and curriculum begun in EDUC 220. Students work with Cornell service staff to accomplish a variety of learning goals selected by the employees. Students receive in-service training and support. Seminars examine the impact of gender, race, and social class on learning and educational opportunity.

EDUC 240(2400) The Art of Teaching (CA)
Fall and spring. 3 credits. B. Heath-Camp.
Exploratory course designed for students of all backgrounds and interests who have a desire to learn more about teaching. Teaching takes place in a variety of contexts from the family to the workplace and this course endeavors to examine the elements of teaching that transcend the typical school-teaching environment. Designed to guide students in reflecting upon their experiences to help them better understand the decisions they make as teachers. Students have the opportunity to pursue their own interests through a teaching fieldwork assignment. Possible field experiences range from large group to tutorial situations, from preschool to adult education, from traditional school subject matters to recreational and occupational areas, and from school-based to nonformal situations. The course work and

readings are designed to build on these experiences throughout the semester and provide concepts and skills to apply in the field.

EDUC 271(2710) Social and Political Context of American Education (HA) (SBA) (D)
Fall. 3 credits. Disc. J. Sipple.
Examines the goals, roles, inputs, and outcomes of schooling in American society and the policy environment in which schools operate. Analyzes controversies and tensions (e.g., equity, market forces, state control) surrounding public education at local, state, and federal levels. Includes current and historical, urban and rural issues and problems.

EDUC 271.1(2710.1) Social and Political Context of American Education Optional Section
Fall. 1 credit. Optional sec for 1 credit. Must be taken with EDUC 271 Social and Political Context of American Education. J. Sipple.

EDUC 311(3110) Educational Psychology (also HD 311[3110]) (KCM) (CA) (D)
Fall. 4 credits. Prerequisite: PSYCH 101 or permission of instructor. S-U or letter grades. Additional disc sec TBA. D. Schrader.
Educational psychology is the application of psychological concepts to educational settings. This course examines the dynamic interaction between people as teachers and learners, schools as social and learning environments, and the sociocultural contexts that influence learning. The focus is on those interactions in cognitive, epistemic, social, moral, and personal domains in educational contexts.

EDUC 331(3310) Careers in Agriculture, Extension, and Adult Education
Fall. 3 credits. Letter grades only. G. Applebee.
Designed to examine program development, methodologies, leadership, evaluation, and implementation in three areas of teaching: adult education, cooperative extension, and agricultural education. The course provides an historical perspective and an introduction to the organization and scope of programs. Students examine career opportunities and characteristics of the professions addressed. Course activities include a class project, field observations, and experiences during arranged times.

EDUC 335(3350) Youth Organizations (CA)
Fall. 3 credits. T. Park.
Visionary, creative, and competent leaders are essential for youth organizations. Class participants learn how to facilitate both youth and adult volunteer leadership development. They examine factors affecting membership, purposes, design, operation, and administration of youth organizations. The course provides students with in-depth learning-by-doing experience of how youth organizations function. Requires field experience with a recognized youth organization.

EDUC 380(3800) Independent Honors Research in Social Science
Fall or spring. 1–6 credits; max. 6 credits may be earned in honors program. Prerequisite: requirements for honors program met. S-U or letter grades. Staff.

EDUC 404(4040) Learning and Teaching I
Fall. 4 credits. Prerequisite: admission to Cornell Teacher Education program or permission of instructor. Letter grades. D. Trumbull.
Designed to foster development of pedagogical and reflective understanding crucial to good teaching. Students explore what it means to understand and teach through examining key disciplinary topics, which requires rethinking disciplinary knowledge, assessment of learning, and motivation. Required fieldwork (4 hours weekly) focuses on students' understandings of pupils and classroom structures.

EDUC 405(4050) Learning and Teaching II
Spring. 4 credits. Prerequisite: admission to Cornell Teacher Education program or permission of instructor. Letter grades. B. Crawford.
Important part of a sequence of courses and experiences intended to lead to excellence in science, agricultural science, and mathematics teaching. Prospective teachers develop understanding and skills in effective planning, instruction, and assessment of students studying agricultural science, mathematics, and science in middle and high school. The course is intended to integrate theory and practice associated with learning and teaching in school classroom settings and includes a minimum of 40 hours of fieldwork in area classrooms.

EDUC 420(4200) Field Experience
Fall or spring. 1–4 credits. Undergraduates must attach to their course enrollment material written permission from faculty member who will supervise work and assign grade. S-U or letter grades. Staff.
Students may engage in planned, semiprofessional, or professional practice in an educational enterprise. Each student prepares a plan of action including rationale, purposes, and procedures and arranges with a faculty member to supervise and evaluate their field experience.

EDUC 441(4410) Language, Literacy, and Schooling
Spring. 3 or 4 credits. Lab TBA. T. Park.
Foundation for literacy activities in secondary education. Examines current research, policy, and practice relating to the acquisition of first and second languages, the dynamics of literacy in school contexts, and the development of academic language proficiency. The fourth credit hour requires a research project based on fieldwork.

EDUC 451(4510) Multiculturalism and Education (also AM ST/LSP 451[4510]) (D)
Fall. 3 credits. Letter grades. S. Villenas.
This course explores research on race, ethnicity, and language in American education. It examines historical and current patterns of minority school achievement and the cultural premises undergirding educational practices in diverse communities and schools. Policies, programmatic and pedagogical responses to diversity, including multicultural and bilingual education, are addressed.

[EDUC 452(4520) Multicultural Issues in Secondary Education (D)
Fall. 1 credit. Prerequisites: permission of instructor. Corequisite: EDUC 451. Letter grades. Next offered 2008–2009. Staff.]

EDUC 459(4590) Educational Innovations in Africa and the Diaspora (also AS&RC 459[4601]) (D)
Fall. 3 credits; 4 in College of Arts and Sciences. N. Assié-Lumumba.
Deals with educational innovations geared to promoting equal opportunity based on gender, race and class, in Africa and the African Diaspora. After introducing the concepts and theories of education and innovations and the stages of innovation as planned change, the course focuses on concrete cases and different types of educational innovations. Selected case studies, in the United States, include the creation and expansion of historically black institutions with a focus on Tuskegee Institute (now Tuskegee University), Lincoln University, Spelman College, and the Westside Preparatory School in Chicago. The African cases studied include African languages for instruction in Nigeria, science education also in Nigeria, Ujamaa and education for self-reliance in Tanzania, classroom action research in Lesotho, Information Communication Technologies (ICTs) in African higher education with a focus on African Virtual Universities (AVU), the application of the Global Development Learning Network (GDLN) in Côte d'Ivoire, and OnLine learning in South Africa.

EDUC 463(4630) Policies, Practices, and Critical Issues of Distance Learning in Developing Countries
Summer. 3 credits. S-U or letter grades. N. Assié-Lumumba.
Distance learning is increasingly being adopted to respond to the high demand for education in developing countries. This course critically analyzes distance education for the general population as well as specific social and professional categories. A typology of the ICTs (information and communication technologies) used and the different forms of virtual learning institutions are examined. Case studies include single-mode and dual-mode institutions in Africa, Asia, and Latin American countries and also eLearning programs designed in industrial countries for developing countries.

EDUC 494(4940) Special Topics in Education
Fall, spring, or summer. 4 credits max. Prerequisite: permission of instructor. S-U or letter grades. Staff.
The department teaches "trial" courses under this number. Offerings vary by semester, and will be advertised by the department before the semester starts. Courses offered under this number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

EDUC 497(4970) Individual Study in Education
Fall, spring, or summer. 1–3 credits. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall). Staff.
A student may, with approval of a faculty advisor, study a problem or topic not covered in a regular course or may undertake tutorial study of an independent nature in an area of educational interest.

EDUC 498(4980) Undergraduate Teaching
Fall or spring. 1 or 2 credits; 4 credits max. during undergraduate career. Prerequisite: GPA of at least 2.7. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall). Staff.
Participating students assist in teaching a course allied with their education and experience. Students are expected to meet regularly with a discussion or laboratory section, to gain teaching experience, and regularly to discuss teaching objectives, techniques, and subject matter with the professor in charge.

EDUC 499(4990) Undergraduate Research
Fall, spring, or summer. 6 credits max. during undergraduate career. Not open to students who have earned 6 or more undergraduate research credits elsewhere in the college. Prerequisite: junior or senior standing; GPA at least 2.7. Students must register using independent study form (available in 140 Roberts Hall). Staff.
Affords opportunities for students to carry out independent research under appropriate supervision. Each student is expected to review pertinent literature, prepare a project outline, conduct the research, and prepare a report.

EDUC 502(5020) Education and Development in Africa (also AS&RC 502[5020])
Spring. 3 credits; 4 in College of Arts and Sciences. S-U or letter grades. N. Assié-Lumumba.
Examines the relationship between education and individual and national development. Besides human capital theory, different paradigms of development, including modernization and dependency theories, and Third World Forum, are examined. Issues discussed include schooling and nonformal education; the role of primary, secondary, and higher education in development; and the issues related to employment, national migration and international brain drain, language, equity in access, output, and outcome based on social class, ethnicity, race, gender, and nationality. Finally, the information and communication technologies (ICTs), indigenous knowledge systems, and the role of higher education in the national, regional, and international contexts and cooperation are discussed.

EDUC 503(5030) Diversity in the Classroom (D)
Fall, spring, or summer. 1 credit for each seminar. Prerequisite: admission to CTE program. S-U or letter grades. Disc TBA. S. Villenas.
Builds on knowledge of literacy and diversity gained from course work and field activities in the CTE program. Students review literacy development, cultural diversity, learning style preferences, fieldwork experiences, and strategies for accommodating difference in teaching.

EDUC 532(5320) Educational Programs in Agricultural Science
Fall. 3 credits. W. Camp.
Overview of the organization and planning processes necessary to operate a successful agricultural science education program in the public schools. Topics include local needs assessments, agricultural advisory boards, community-partnering strategies, program planning, course development, sequencing instruction, professional development. Fieldwork provides experience with New York agricultural education students, teachers, and programs.

EDUC 535(5350) Youth Organizations for Agricultural Science Education
Spring. 3 credits. Prerequisite: senior or graduate standing in Agricultural Science Education. Letter grades only. T. Park.
Provides future agriculture educators a comprehensive overview of the components of an agriculture education program including supervised agricultural experience (SAE) and FFA. Students examine factors affecting membership, purpose, design, operation, and administration of career and technical student organizations and FFA organization, structure, and functions on national, state, and local levels.

EDUC 544(5440) Curriculum and Instruction
Spring. 3 credits. S-U or letter grades. B. Heath-Camp.
The focus of this curriculum and instructional planning course will be on the concepts and principles for developing curriculum and the processes for delivering curriculum. Experiences will be designed to assist in identifying the educational needs of clients/students, selecting curriculum content, designing curricula, and delivering the curriculum.

EDUC 571(5710) Social and Political Context of American Education (HA) (SBA) (D)
Fall. 3 credits. Prerequisites: admission to Cornell Teacher Education Program or permission of instructor. J. Sipple.
Examines the goals, roles, inputs, and outcomes of schooling in American society, and the policy environment in which schools operate. Analyzes controversies and tensions (e.g., equity, market forces, state control) surrounding public education at local, state, and federal levels. Includes current and historical, urban and rural issues and problems.

EDUC 571.1(5710.1) Social and Political Context of American Education Required Discussion Section
Fall. 1 credit. Required sec for 1 credit. Must be taken with EDUC 571 Social and Political Context of American Education. J. Sipple.

EDUC 578(5780) International Teaching Assistant Development Program (ITADP) Training Course: Cross-Cultural Classroom Dynamics, Pronunciation, and Language, Video Teaching Practicum
Fall and spring. 2 credits. S-U grades only. TBA. ITADP staff.
Designed for first-time international teaching assistants from countries in which English is not the first language. Focuses on three areas: cross-cultural classroom dynamics, video teaching practicum, and language—enhancing communicative competence in English. Through small-group seminars and individual conferences, the ITADP helps international teaching assistants develop their linguistic and pedagogical skills as they gain sensitivity to the dynamics of U.S. classrooms.

EDUC 579(5790) Further Training for International Teaching Assistants
Fall, spring, summer. 2 credits. Prerequisite: EDUC 578. S-U or letter grades. Lec, three contact hours per week. ITADP staff.
Designed for international teaching assistants from countries in which English is not the first language and who have completed EDUC 578, the ITADP follow-up course provides further instruction and practice in oral English and pedagogical skills.

EDUC 601(6010) Secondary Agriculture, Science, and Mathematics Teaching Practicum
Fall or spring. 6 credits. Prerequisite: graduate students enrolled in Cornell Teacher Education Program. S-U grades only. D. Trumbull, B. Crawford, W. Camp, and T. Park.
Supervised student teaching in agriculture, mathematics or science at the secondary level. Program includes teaching in a local school for 14 weeks.

EDUC 602(6020) Practicum Seminar
Fall or spring. 9 credits. Prerequisite: EDUC 601 or permission of instructor. W. Camp, B. Crawford, D. Trumbull, and T. Park.
Begins with full-day sessions of intensive consideration of classroom practice relevant to all aspects of student teaching. Assignments and an online seminar during the semester require students to use theories to develop and evaluate teaching materials and practices. Students also complete an extensive portfolio documenting their work.

[EDUC 614(6140) Gender, Context, and Epistemological Development (also FGSS 624[6240]) (D)
Fall. 3 credits. S-U or letter grades. Offered alternate years; next offered 2008–2009. D. Schrader.
This seminar explores concepts of personal epistemological development and how social context and gender influence how we know and how we think. We examine the dynamic interactions between individuals' view of the nature of knowledge, metacognitive awareness of thought processes and strategies, and social contexts of education and real life.]

EDUC 616(6160) Moral Psychology and Education (also FGSS 606[6060])
Fall. 3 credits. Prerequisites: EDUC 311, graduate standing or permission of instructor. S-U or letter grades. Offered alternate years. D. Schrader.
This seminar examines questions of the psychological development of knowing what is right, just, good, and of value. We study moral development from cognitive-developmental, social-contextual, normative, and gendered perspectives. Topics vary by semester but include the relationship between judgment and action, moral education, social aggression, moral leadership, and integrity.

EDUC 617(6170) Psychology of Adolescence in Case Study (also FGSS 618[6180])
Spring. 3 credits. Prerequisite: any one of the following: EDUC 311, HD 617, or permission of instructor. S-U or letter grades. D. Schrader.
Adolescent psychological development is examined from the perspective of the individual subject and the researcher. Using a

case study approach we explore classic and contemporary theories of adolescence, relying on primary source readings and first-person accounts to give us insight into adolescent issues, such as identity, values, and behaviors.

EDUC 620(6200) Internship In Education
Fall or spring. 1–6 credits. S-U or letter grades. Each student, before course enrollment, must obtain approval of faculty member who will assume responsibility for supervising work. Staff.
Opportunity for practical experience in educational professions development.

[EDUC 621(6210) Work-Experience Coordinator Certification Course I
Summer. 3 credits. Prerequisite for EDUC 622. S-U or letter grades. Next offered 2008–2009. Staff.
First of two-course sequence designed to meet state certification requirements for Coordinator of Diversified Cooperative Work Experience programs.]

[EDUC 622(6220) Work-Experience Coordinator Certification Course II
Summer. 3 credits. Prerequisite: EDUC 621. Next offered 2008–2009. Staff.
Second of two-course sequence designed to meet state certification requirements for Coordinator of Diversified Cooperative Work Experience programs.]

EDUC 633(6330) Program Planning in Adult and Extension Education
Spring. 3 credits. S-U or letter grades. Offered alternate years. A. Wilson.
Examines current social and economic conditions affecting agricultural, extension, and adult education. Applies principles, objectives, strategies, and sources of information to program planning. Participants have an opportunity to observe ongoing programs in agricultural, extension, and adult education and to pursue individual interests in program development and improvement.

EDUC 647(6470) Innovative Teaching in the Sciences
Spring. 3 credits. S-U or letter grades. B. Crawford.
This seminar on innovative ways to teach is designed for doctoral and master's-level students in education, sciences, math, and possibly other disciplines, including extension and outreach. Readings will include issues of gender and underrepresented populations in science, math and engineering. Students will design inquiry-based instruction in their field.

EDUC 651(6510) Anthropology and Education
Spring. 3 credits. Letter grades. Lec. S. Villenas.
A study of schooling and education from anthropological perspectives and ethnographic methodology. Participants examine teaching and learning in families, communities, and schools as cultural processes. Some topics include the differential school achievements of racial/ethnic minorities, school reform efforts, youth culture and identities, and literacy in adult learning spaces.

EDUC 661(6610) Administration Leadership and Organizational Change
Fall. 3 credits. J. Sipple.
Perspectives on the administration of educational organizations. Considers social science, legal and ethical theories, and their application to both public schools and higher education. Intended for students who are considering careers as educational administrators, as well as for those who want to further their understanding of educational organizations.

EDUC 662(6620) Evaluation Design
Spring. 3 credits. Prerequisite: survey of research methods (or other graduate level class in research methods), statistics. S-U grades only. M. Constas.
This course is designed to introduce graduate students to the principles and practices of program evaluation. It addresses practical realities and political features of a range of evaluation designs that may be used to support decision making related to educational, social, and community-based programs. Students who enroll in the class will become familiar with the technical characteristics, practical realities, and political features of a range of evaluation designs that may be used to support decision making related to educational, social, and community-based programs. Course readings, class discussions, and assignments will support the development of the proposal.

EDUC 664(6640) Methods for Interpretive Research
Spring. 3 credits. Prerequisites: course in research methods/research design. S-U or letter grades. D. Trumbull.
Course addresses the assumptions undergirding interpretive research and explores key methodological approaches to gathering and analyzing evidence. These approaches attend to the complex interactions between the researcher, the researched, and the context. Students carry out an actual study for the course, allowing them to experience doing actual research.

EDUC 668(6680) Narrative Inquiry in Social Science and Action Research
Spring. 3 credits. S-U or letter grades. S. Peters.
Provides an introduction to the theory and practice of narrative inquiry in action-oriented social science research. It includes a range of theoretical and practical topics related to narrative inquiry, taking an approach that combines seminar and workshop formats. Class sessions and assignments provide students with opportunities to practice elements of narrative inquiry, and to develop draft proposals for research projects that incorporate a narrative orientation.

EDUC 671(6710) American School Reform: Organizational and Sociological Perspectives
Spring. 3 credits. S-U or letter grades. J. Sipple.
For individuals interested in the role of schools in society and in organizational behavior and public policy. This seminar investigates the sociological functions of schooling, including the stability of school organization given the long history of policy initiatives designed to reform schools. The focus is American K–12 public education, though issues of pre-K, private, and post-secondary education are covered.

EDUC 680(6800) Foundations of Adult and Extension Education
Fall. 3 credits. Limited to 20 students. S-U or letter grades. Offered alternate years. A. Wilson.
Analysis of alternative purposes, nature, and scope of extension, adult, and continuing education programs in the United States and abroad, with emphasis on the relationship of programs to historical, cultural, political, and social settings. Examines definitions, conceptual controversies, philosophical issues, and current research directions through a seminar approach.

EDUC 681(6810) Democracy, Science, and Education
Spring. 3 credits. S-U or letter grades. S. Peters.
Explores the actual and potential connections between democracy, science, and education. The first half of the course examines several different models and theories of democracy. Attention is focused on how the nature and practice of citizenship and politics are conceptualized under each of these models, and the implications of these conceptualizations for the political and civic education roles and work of teachers, scientists, adult educators, community development practitioners, and community organizers. The second half of the course involves a critical examination of the roles that scientific methods, expertise, technologies, and knowledge do, might, and/or should play in addressing social problems.

EDUC 682(6820) Community Education and Development
Fall. 3 credits. Limited to 25 students. Letter grades only. S. Peters.
Offers an opportunity for students to engage in a critical study of the purposes and practices of professional organizers and educators in community and economic development initiatives. The course places a special focus on the civic or democratic dimensions of educational practice. Civic practice in community education and development is viewed in relation to the craft of "educational organizing" as a vehicle for social learning and collective action. Key philosophies and traditions of educational organizing are studied and analyzed in their historical, cultural, social, and political context, with an eye toward implications for contemporary practice in a broad range of settings.

EDUC 683(6830) Adult Education and Globalization: Comparative Perspectives
Fall. 3 credits. S-U or letter grades. M. Kroma.
Examines the interconnections between particular economic and political systems as key to understanding the relationships of adult education to society. Employing a critical framework, the course explores emerging local, regional and national responses in adult education that are planting seeds of change and creativity in ways that are nurturing new forms of educational life in the context of globalization. Particular attention is paid to modes of social analyses that explore the relationship between adult education and social structural factors, including gender, race and class, to inform a sense of place and social location.

EDUC 685(6850) Training and Development: Theory and Practice (also IARD 685[6850])
Spring. 4 credits. S-U or letter grades. M. Kroma.
Prepares professionals to design, administer and facilitate training programs responsive to the challenges of sustainability in our world system. Focuses on the theory and practice of training for the development of human resources in small farm agriculture, rural health and nutrition and literacy. Through in-depth discursive critiques of selected readings, students develop insights into the range of methods and strategies employed in situation analysis, the analysis of socioeconomic, sociocultural, and sociopolitical contexts of training programs; facilitation of participatory training programs for the development of human resources in small holder agriculture, rural health and nutrition, and community building. The specific role of training/education in larger change-promoting systems is also explored. The course is appropriate for persons likely to be playing professional roles as educator-trainers, scientists, administrators, and social organizers in rural and agricultural development programs in international as well as domestic contexts.

EDUC 694(6940) Special Topics in Education
Fall, spring, or summer. 1–3 credits. Prerequisite: permission of instructor. S-U or letter grades. Staff.
Topics TBA.

EDUC 700(7000) Directed Readings
Fall, spring, or summer. 6 credits, variable. Prerequisite: graduate standing; permission of instructor. S-U or letter grades. Staff.
For study that predominantly involves library research and independent study.

EDUC 701(7010) Empirical Research
Fall, spring, or summer. 6 credits, variable. Prerequisite: graduate standing; permission of instructor. S-U or letter grades. Staff.
For study that primarily involves collection and analysis of research data.

EDUC 702(7020) Practicum
Fall, spring, or summer. 6 credits, variable. Prerequisite: graduate standing; permission of instructor. S-U or letter grades. Staff.
For study that predominantly involves field experience in community settings.

EDUC 703(7030) Teaching Assistantship
Fall, spring, or summer. 6 credits, variable. Prerequisite: graduate standing; permission of instructor. S-U or letter grades. Staff.
For students assisting faculty with instruction. Does not apply to work for which students receive financial compensation.

EDUC 704(7040) Research Assistantship
Fall, spring, or summer. 6 credits, variable. Prerequisite: graduate standing; permission of instructor. S-U or letter grades. Staff.
For students assisting faculty with research. Does not apply to work for which students receive financial compensation.

EDUC 705(7050) Extension Assistantship
Fall, spring, or summer. 6 credits, variable. Prerequisite: graduate standing; permission of instructor. S-U or letter grades. Staff.
For students assisting faculty with extension activities. Does not apply to work for which students receive financial compensation.

EDUC 718(7180) Adult Learning and Development
Spring. 3 credits. R. Caffarella.
Seminar provides an opportunity for students to review and critique the seminal and current scholarly work in learning in adulthood. Emphasis is placed on three ways of framing adult learning: psychological, social, and cultural. Specific content areas, which vary by semester, are also explored (for example, transformational learning, experiential learning, intelligence and aging, non-western perspectives of learning, spiritual learning). Implications of this knowledge base relevant to the practice of educating adults in formal and non-formal settings, such as educational institutions, community based-setting, health care, and the workplace, and through informal learning situations are also discussed.

EDUC 762(7620) Comparative and International Education
Summer. 3 credits. S-U or letter grades. N. Assié-Lumumba.
Seminar that critically analyzes education conceived both as a universal social institution and a reflection of cultural, economic, and political dynamics of the local and global contexts. The analysis focuses on policies, organization, and the functioning of education in industrial, new/emerging economies, and developing countries. Specific case studies are drawn from different countries.

EDUC 783(7830) Farmer-Centered Research and Extension (also IARD 783[7830])
Fall. 3 credits. S-U or letter grades. M. Kroma.
Forum for discussion and critical analyses of participatory research and extension approaches in agriculture and natural resource management in the complex and diverse environments characteristic of many developing countries. Theoretical and philosophical arguments that underpin participatory research and extension, as well as current tools and techniques for facilitating participation and social learning are examined. Case studies and individual projects related to farmer-centered research and extension provide a focus for analyses. The course also explores and pays special attention to the challenges and opportunities related to institutionalization of participatory research and extension for sustainable agriculture and natural resource management.

EDUC 800(8900) Master's-Level Thesis Research
Fall or spring. Credit TBA. Each student, before course enrollment, must obtain approval of faculty member who will assume responsibility for guiding work. S-U or letter grades. Times TBA. Staff.

EDUC 900(9900) Doctoral-Level Thesis Research
Fall or spring. Credit TBA. Each student, before course enrollment, must obtain approval of faculty member who will assume responsibility for guiding work. S-U or letter grades. Times TBA. Staff.
Doctoral or other research and development projects for Ph.D. students.

ENTOMOLOGY

J. G Scott, chair (2130 Comstock Hall, 255-7723); A. M. Agnello, A. Agrawal, N. W. Calderone, B. N. Danforth, A. DiTommaso, T. Eisner, G. M. English-Loeb, P. P. Feeny, C. Gilbert, A. E. Hajek, L. C. Harrington, G. W. Hudler, B. P. Lazzaro, J. K. Liebherr, C. Linn, J. E. Losey, M. Luckow, J. P. Nyrop, D. Pimentel, L. S. Rayor, J. P. Sanderson, E. J. Shields, J. S. Thaler, W. M. Tingey, P. A. Weston

Courses by Subject

Apiculture: 260, 264
Behavior: 215, 315, 325, 394, 471, 662
Conservation: 344
Ecology: 369, 452, 455, 456, 470, 672, 757
Introductory courses: 201, 210, 212, 215, 241
Medical and veterinary entomology: 210, 352, 353
Morphology: 322
Outreach: 335, 336
Pathology: 463, 670
Pest management: 241, 277, 420, 441, 443, 444, 477, 644, 670
Physiology, development, and toxicology: 370, 394, 400, 483, 490, 685
Systematics: 331, 332, 333, 440, 453, 634, 635, 655

Note: Class meeting times are accurate at the time of publication. If changes occur, the department will provide new information as soon as possible. Check the web site for updates.

ENTOM 201(2010) Alien Empire: Bizarre Biology of Bugs
Spring. 2 or 3 credits. S-U or letter grades. Optional field trips, required lab demonstrations. B. N. Danforth.
Insects are the most abundant and diverse animals on earth. This course explores the bizarre biology of insects by examining their evolutionary history, anatomy, development, feeding habits, life-history strategies, behavior, and their interactions with humans (both positive and negative) through history. Optional field trips and one open lab provide hands-on opportunities for examining these amazing animals. The 3-credit option will involve an additional class meeting per week.

ENTOM 210(2100) Plagues and People
Fall. 2 or 3 credits. Prerequisites: introductory biology or permission of instructor. Offered alternate years. L. C. Harrington.
Human diseases transmitted by insects and related forms (arthropods) have affected human lives and society through history. This course focuses on the pathogens, parasites, and arthropods causing human plagues. Those plagues that have had the greatest impact on human culture and expression are emphasized. Lectures are supplemented with readings and films. Also addresses emerging diseases, bioterrorism, and future plagues. Students taking the course for 3 credits

participate in readings, presentations/discussions each week (on Fridays), weekly readings quizzes, and have a comprehensive final project.

ENTOM 212(2120) Insect Biology
Fall. 4 credits. Pre- or corequisites: BIO G 101–102 or equivalent. Lec, lab. Lab fee: $40. J. P. Sanderson.
Introduces the science of entomology by focusing on basic principles of systematics, morphology, physiology, behavior, and ecology of insects. The laboratory in early fall includes field trips to collect and study insects in the natural environment. Requires a collection emphasizing ecological, behavioral, and taxonomic categories.

ENTOM 215(2150) Spider Biology: Life on a Silken Thread
Fall. 2 credits. Prerequisite: introductory biology or permission of instructor. S-U or letter grades. Lec. L. S. Rayor.
Introduction to the fascinating world of spiders. Explores evolution, ecology, behavior, and physiology of spiders and their close kin from a modern perspective. Topics include identification of major spider families, spiders' unique use of silk, risky courtship, predatory behavior, diverse life styles, social spiders, and potential use in IPM.

ENTOM 241(2410) Insect Pest Management for Practitioners
Spring. 3 credits. Limited to 18 students. Prerequisites: BIO G 101–102 or equivalent. Lec, lab/disc. W. M. Tingey.
Introduction to insect pest management in plant or animal protection for those preparing for careers in extension, service, and production. Emphasizes pest monitoring, sight identification, diagnosis, decision-making, and management tactics for the major groups of insect and arthropod pests affecting field, forage, and vegetable crops; floriculture, woody ornamentals, and turf; urban environments and public health; veterinary, dairy, livestock, and poultry. Five off-campus laboratory field trips with demonstrations of pest management decision-making, pest-monitoring tools, and pesticide-application equipment.

[ENTOM 260(2600) Biology of the Honey Bee
Fall. 2 credits. Lec. Offered alternate years; next offered 2008–2009. N. W. Calderone.
Introduces students to the life history, physiology, ecology, and behavior of honey bees. Reviews classical and contemporary research on the dance language, chemical communication, behavioral genetics, division of labor, and evolution of social behavior. Also includes lectures on pollination of agricultural crops, honey and beeswax, bees in ancient and modern rituals, Africanized honey bees, and insect politics.]

[ENTOM 264(2640) Practical Beekeeping
Fall. 1 credit. Limited to 20 students. Pre- or corequisite: ENTOM 260. Lab. Offered alternate years; next offered 2008–2009. N. W. Calderone.
Consists of 14 laboratory sessions that acquaint students with practical methods of colony management. Laboratories involve hands-on work with honey bee colonies and equipment. Topics include management of bees for apple pollination, honey harvesting and processing, and disease identification/control. The class makes a number of field trips to commercial beekeeping operations. Students conduct simple experiments to demonstrate color and odor perception by bees, as well as the chemical basis for swarming, nest guarding, and mating.]

ENTOM 277(2770) Invasive Species and Natural Enemies
Spring. 2–3 credits. S-U grades optional. Lecs, lab, demonstration; optional field trip, optional disc session offered for 1 credit. A. Hajek and J. Nyrop.
The purpose of this course is for students to learn about the looming problems caused by invasive species and use of biological control against invasives and other pests. These topics are obviously grounded in biology; however, they have social, economic and philosophical links. Many research projects on invasive species and biological control are conducted on Cornell campus; examples of research will be provided, including talks by guest lecturers. Subjects covered will include basic concepts of biological invasion and biological control. These subjects fit well together because one of the first lines of defense against invasive species is use of biological control agents. Invasive species impact agriculture but also increasingly affect and can permanently change natural systems. Natural enemies used for biological control that will be discussed include predators, parasitoids, pathogens, herbivores and antagonists to control vertebrate, invertebrate, and microbial pests and weeds.

ENTOM 315(3150) Spider Biology
Fall. 3 credits. Prerequisite: introductory biology or permission of instructor. Letter grades only. Lec. L. S. Rayor.
In-depth introduction to the fascinating world of spiders and their relatives. Meets concurrently with ENTOM 215 (2 credits). Students in ENTOM 315 meet for another hour with additional coverage of current topics in arachnology and developing spider identification skills. Entomology majors and biology majors in the Insect Biology Program of Study should take ENTOM 315 rather than 215. Students may not take both ENTOM 215 and 315 for credit.

[ENTOM 325(3250) Insect Behavior (also BIONB 325[3250])
Spring. 3 credits. Prerequisite: introductory biology and either ENTOM 212 or BIONB 221. Lec. Offered alternate years; next offered 2008–2009. L. S. Rayor.
Insects are the most diverse organisms on earth, with equally diverse behavior. This course explores the behavior of insects, ranging from the individual sensory and physiological mechanisms that are the basis of insect behavior, to the behavioral dynamics of foraging, courtship, parental care, and social behavior. Topics include insect learning, perceptual abilities, host finding strategies, predation, pollination, and examination of current issues in insect behavior.]

[ENTOM 331(3310) Insect Phylogeny and Evolution
Spring. 3 credits. Prerequisite: ENTOM 212. Lab fee: $40. Offered alternate years; next offered 2008–2009. B. N. Danforth.
This course will provide a broad overview of insect diversity, morphology, phylogeny, evolution, and fossil history. Evolution of the insects will be discussed in light of real data sets based on morphology and/or DNA sequence data. Basic principles of phylogeny reconstruction using both morphological and DNA sequence data will be presented using published data sets. Analytical methods such as parsimony, maximum likelihood, and Bayesian methods will be discussed and compared. We will also cover how phylogenies are used to analyze evolutionary patterns, such as historical biogeography, co-evolution, and host–parasite relationships.]

[ENTOM 332(3320) Insect Phylogeny and Evolution Laboratory
Spring. 1 credit. Prerequisite: ENTOM 212 lab. Next offered 2008–2009. B. N. Danforth.
Introduction of the diversity, phylogeny, evolution, and fossil history of insects. Includes lab practice in insect morphology, insect diversity, and phylogenetic analysis. Entomology undergraduates wishing to count this course toward their Group A requirement are required to take the laboratory, as well as the lecture for a total of 4 credits.]

ENTOM 333(3330) Maggots, Grubs, and Cutworms: Larval Insect Biology
Fall. 3 credits. Prerequisites: ENTOM 212 or permission of instructor. S-U or letter grades. Offered alternate years. J. K. Liebherr.
The evolutionary history of the Holometabola has been greatly informed by attributes of their larvae. This course introduces students to the biology, anatomy, and natural history of holometabolous insect larvae. The lab includes field sampling, curation of field-collected specimens, and identification of unknowns. Development of a small larval collection required.

ENTOM 335(3350) Naturalist Outreach Practicum
Fall. 3 credits. Prerequisite: introductory biology. S-U or letter grades. L. S. Rayor.
Learn the skills to do effective scientific outreach. This interdisciplinary course combines lectures on topics relevant to teaching about natural history, with more pedagogic lectures on developing and presenting scientific inquiry–based presentations. The course emphasizes developing different approaches to effectively communicate science at different scales from classroom settings, through museum programs, to large outreach events. Students participate in the Naturalist Speakers Bureau to provide lively multimedia presentations in classrooms throughout the region. With feedback from peers and instructors, students develop their own biological presentations, display materials, and teacher resource guides.

ENTOM 336(3360) Naturalist Outreach in Biology
Fall. 1–2 credits, variable. Prerequisite: ENTOM 335. S-U or letter grades. L. S. Rayor.
Students enrolled in the Naturalist Outreach Practicum will serve as members of the Naturalist Speakers Bureau to provide lively multimedia presentations on the ecology and behavior of organisms to second through H.S. classrooms throughout the region. With feedback from peers and instructors, students develop their own science-based presentation, display materials, and teacher resource guides. For students who have already taken Naturalist Outreach Practicum (ENTOM 335) who wish to continue doing scientific outreach. This course can be taken twice.

ENTOM 344(3440) Insect Conservation Biology
Spring. 3 credits. Prerequisite: entomology or conservation biology course or permission of instructor. S-U or letter grades. Lec. Offered alternate years. J. E. Losey.
In-depth look at the concepts and issues surrounding the conservation of insects and other invertebrates. Topics include sampling rare populations; insect conservation genetics; the role of phylogeny in determining conservation priorities; refuge design; saving individual species; plus the unique political, social, and ethical aspects of insect conservation and preservation of their ecological services (i.e., pollination, decomposition, pest suppression, and insectivore food sources).

[ENTOM 352(3520) Medical and Veterinary Entomology
Fall. 3 credits. Prerequisites: BIO G 101–102 or permission of instructor. S-U or letter grades. Offered alternate years; next offered 2008–2009. L. C. Harrington.
Diseases resulting from arthropod-borne pathogens (such as malaria, West Nile virus, dengue, and yellow fever) cause considerable human and animal suffering and death worldwide. This course explores the impact of vector-borne disease and provides a comprehensive overview of the fields of medical and veterinary entomology. The goal is to encourage an understanding of evolutionary and ecological issues associated with disease transmission. Undergraduate and graduate students from entomology as well as other disciplines including pre-medical and veterinary students are encouraged to enroll.]

[ENTOM 353(3530) Lab in Medical and Veterinary Entomology
Fall. 1 credit. Prerequisites: ENTOM 352 at the same time or have taken another Medical/Veterinary Entomology course. S-U or letter grades. Next offered 2008–2009. L. C. Harrington.
The laboratory compliments the lecture course, ENTOM 352. Includes field trips, collection and identification and arthropods of medical/veterinary importance, and hands-on experience with modern laboratory research methods.]

ENTOM 369(3690) Chemical Ecology (also BIOEE/BIONB 369[3690])
Spring. 3 credits. Prerequisites: one semester of introductory biology for majors or nonmajors and one semester of introductory chemistry for majors or nonmajors or equivalents, or permission of instructor. S-U or letter grades. Lec. A. Agrawal, G. Jander, A. Kessler, and J. Thaler.
For description, see BIOEE 369.

[ENTOM 370(3700) Pesticides, the Environment, and Human Health (also TOX 370[3700])
Fall. 2 credits. Prerequisites: BIO G 101–102 or equivalent. Lec. Offered alternate years; next offered 2008–2009. J. G. Scott.
Survey of the different types of pesticides, their uses, properties, and effects on the environment. Discusses the risks, benefits, regulation, politics, and current controversies associated with pesticide use and genetically modified crops.]

[ENTOM 400(4000) Insect Development (also BIOGD 402[4020])]

[ENTOM 420(4200) Grape Pest Management (also PL PA 420[4200])]

[ENTOM 440(4400) Phylogenetic Systematics (also BIOPL 440[4400])
Spring. 4 credits. Prerequisites: intro biology or permission of instructor. Lec and lab. Next offered 2008–2009. K. Nixon.
For description, see BIOPL 440.]

[ENTOM 443(4430) Entomology and Pathology of Trees and Shrubs (also PL PA 443[4430])
Fall. 4 credits. Prerequisites: ENTOM 212 or equivalent and PL PA 241 or equivalent. S-U or letter grades. Offered alternate years; next offered 2008–2009. P. A. Weston and G. W. Hudler.
For students preparing for careers in horticulture, urban forestry, pest management, and natural history/science education. Deals with the nature, diagnosis, assessment, and management of insect and disease pests on trees and shrubs in forests, urban landscapes, Christmas tree plantations, and other sites where intensive pest management is practiced.]

ENTOM 444(4440) Integrated Pest Management (also CSS 444[4440])
Fall. 4 credits. Prerequisite: introductory biology or permission of instructor. Lec. J. E. Losey and A. DiTommaso.
Lectures integrate the principles of pest control, ecology, and economics in the management of pests across multiple systems. Labs consist of exercises to reinforce concepts presented in lecture and demonstrate pest monitoring techniques and the application of computer technology to management problems.

[ENTOM 453(4530) Principles and Practice of Historical Biogeography (also BIOPL 453[4530])
Fall. 3 credits. Prerequisite: systematics course or permission of instructor. S-U or letter grades. Lec, lab. Offered alternate years; next offered 2008–2009. J. K. Liebherr and M. Luckow.
Survey of techniques in historical biogeography, and the development of modern biogeographic theory in the context of classical, ecological, and phylogenetic analytical methods. Presents geological and paleontological aspects of biogeography and discusses large-scale biogeographic patterns. Labs focus on computer applications and discussion of controversial issues.]

[ENTOM 455(4550) Insect Ecology (also BIOEE 455[4550])
Fall. 4 credits. Recommended: ENTOM 212 or BIOEE 261 or permission of instructor. S-U or letter grades. Offered alternate years; next offered 2008–2009. J. S. Thaler.
Focuses on individual and population aspects of insect ecology as well as some topics in community and ecosystem ecology. Stresses the importance of interactions with the biotic and abiotic environment stressed. Laboratory includes indoor and outdoor field trips illustrating the major concepts in insect ecology as well as experimental techniques.]

[ENTOM 463(4630) Invertebrate Pathology
Fall. 4 credits. Prerequisites: one year introductory biology. S-U or letter grades. Lec, lab. Offered alternate years; next offered 2008–2009. A. E. Hajek.
Lecture presents principles of pathology as applied to invertebrates. Topics include noninfectious and infectious diseases caused by viruses, bacteria, fungi, protozoa, and nematodes, epizootiology of insect diseases, and use of pathogens for control. Lab involves a diversity of pathogens and hosts using techniques such as microinjection, electrophoresis, immunoassay, density gradient centrifugation, soil extraction, and computer simulation.]

ENTOM 470(4700) Ecological Genetics (also BIOEE 480[4800])
Spring. 3 credits. Prerequisites: BIOEE 278 or permission of instructor. S-U or letter grades. Offered alternate years. B. P. Lazzaro.
Focuses on the application of population genetic concepts in ecological or applied contexts. Emphasizes measuring adaptation in natural populations, detecting the effects of population demography, and determining the genetic basis of quantitative traits. Draws examples from primary research on animals and plants to illustrate experimental techniques and methods of data analysis on single-gene, multi-locus and genome-wide scales.

[ENTOM 483(4830) Insect Physiology
Fall. 4 credits. Prerequisite: ENTOM 212 or permission of instructor. Lec, lab. Offered alternate years; next offered 2008–2009. C. Gilbert.
Introduction to the often unique ways in which insects have met their basic needs. Examines each organ system with emphasis on basic principles and specific examples. Also introduces students to some common methods used in physiological research and to the critical reading of scientific literature.]

[ENTOM 490(4900) Toxicology of Insecticides (also TOX 490[4900])
Spring. 3 credits. Prerequisite: general chemistry course. S-U or letter grades. Lec. Offered alternate years; next offered 2008–2009. J. G. Scott.
History, metabolism, and mechanism of action of genetically modified, synthetic, and naturally occurring insecticides. Discusses insecticide resistance, resistance management, and new approaches to insect control with genetically modified organisms.]

ENTOM 494(4940) Special Topics in Entomology
Fall or spring. 4 credits max. S-U or letter grades. Staff.
The department teaches "trial" courses under this number. Offerings vary by semester, and are advertised by the department before the semester starts. Courses offered under the number will be approved by the department curriculum committee, and the same course is not to be offered more than twice under this number.

ENTOM 497(4970) Individual Study in Entomology
Fall or spring. Credit TBA. Prerequisite: permission of instructor. Students must register using independent study form (available in 140 Roberts Hall). Staff.

ENTOM 498(4980) Undergraduate Teaching
Fall or spring. Credit TBA. Prerequisite: permission of instructor. Students must

register using independent study form (available in 140 Roberts Hall). Staff.
Undergraduate teaching assistance in an entomology course by agreement with the instructor. Participating students assist in teaching a course allied with their education and experience. Students are expected to meet regularly with a discussion or laboratory section, to gain teaching experience, and regularly to discuss teaching objectives, techniques, and subject matter with the professor in charge.

ENTOM 634(6340) Special Topics in Systematic Entomology
Fall or spring; on demand. 2–4 credits. Prerequisite: permission of instructor. Staff.
Lectures on the classification, evolution, and bionomics of selected taxa, with accompanying laboratory studies on identification and comparative morphology. Collections sometimes required.

[ENTOM 655(6550) Nomenclature Seminar
Spring. 1 credit. S-U or letter grades. Lec. Next offered 2008–2009. J. K. Liebherr.
This seminar will expose you to the rules of zoological nomenclature supported by the International Trust for Zoological Nomenclature. These rules will be viewed in the context of necessary principles for any system that encodes names of biological entities. The class benefits from our outstanding Comstock Memorial Library, from which we will view examples of important entomological works to gain an understanding of how the International Code for Zoological Nomenclature has been implemented.]

ENTOM 662(6620) Insect Behavior Seminar
Spring. 2 credits. Prerequisites: permission of instructor or ENTOM 212 and BIONB 221 or equivalents. S-U or letter grades. Offered alternate years. C. Gilbert.

[ENTOM 670(6700) Seminar on Biological Control
Fall. 1 credit. Prerequisite: ENTOM 277, 440, or 463 or permission of instructor. S-U or letter grades. Offered alternate years; next offered 2008–2009. A. E. Hajek.
Upper-level seminar series in biological control covering topics chosen by participating students and faculty. Weekly discussion groups with each participant presenting at least one oral report based on independent reading or research focusing on a central theme for the semester.]

[ENTOM 685(6850) Seminar in Insect Physiology
Spring. 1 credit. Prerequisite: permission of instructor. S-U or letter grades. Offered alternate years; next offered 2008–2009. C. Gilbert.]

ENTOM 707(7070) Individual Study for Graduate Students
Fall or spring. Credit TBA. Prerequisite: permission of instructor. Not for thesis research. Staff.

ENTOM 709(7090) Teaching Entomology
Credit TBA. Staff.
Teaching entomology or for extension training.

ENTOM 757(7570) Spatial Population Ecology (also BIOEE 757[7570])
Spring. 1 credit; may be repeated for credit. Limited enrollment. Letter grades; S-U grades by permission only. S. van Nouhuys.
For description see, BIOEE 757.

ENTOM 767(7670) Current Topics in Entomology
Fall and spring. 1 credit. Requirement for first- and second-year entomology graduate students. S-U grades only. A. Hajek and B. N. Danforth.
After the Jugatae seminar, the students taking the course discuss the seminar and additional papers with the speakers from 4:30 to 5:30 in 2123 Comstock Hall.

ENTOM 800(8000) Master's-Level Thesis Research
Fall and spring. 15 credits per semester if taking no classes; if taking other courses, use ENTOM 800 to bring yourself up to a total of 15 credits. Prerequisite: permission of instructor. S-U or letter grades. Staff.
Research at the master's level.

ENTOM 900(9000) Doctoral-Level Thesis Research
Fall and spring. 15 credits per semester if taking no classes; if taking other courses, use ENTOM 900 to bring yourself up to a total of 15 credits. Prerequisite: permission of instructor. S-U or letter grades. Staff.
Research at the doctoral level.

Jugatae Seminar
Fall and spring.
Seminar conducted by Jugatae, the entomology club of Cornell University, to discuss topics of interest to its members and guests. All interested undergraduate and graduate students are encouraged to attend.

FOOD SCIENCE

J. H. Hotchkiss, chair (114 Stocking Hall, 255-7912); T. E. Acree, K. J. Arnink, D. M. Barbano, C. A. Batt, K. J. Boor, J. W. Brady, R. B. Gravani, H. T. Lawless, C. Y. Lee, R. H. Liu, D. D. Miller, R. de Mira Orduña, C. I. Moraru, S. J. Mulvaney, A. Orta-Ramirez, J. M. Regenstein, S. S. H. Rizvi, K. J. Siebert, M. Wiedmann

FD SC 101(1010) Science and Technology of Foods
Fall. 1 credit. S-U grades only. J. H. Hotchkiss and staff.
Explores the application of science and technology to foods. Lectures elucidate the role of engineering, biotechnology, chemistry, biochemistry, nutrition, toxicology, and microbiology in supplying the world with safe and nutritious food. An overview of food science as a discipline and career choice is given.

FD SC 102(1020) Exploring Food Processing
Spring. 1 credit. S-U grades only. Five field trips. Staff.
Series of seminars on current technological and regulatory developments in food science. Field trips to five commercial food manufacturing/processing plants are used to illustrate the application of current technologies. A course project, using the Food Science Alumni Network, is required.

FD SC 104(1040) Wines and Vines (also HORT 104[1040])
Spring. 2 or 3 credits. Lec and lab required for undergraduate enology and viticulture students. Lec. (2 cr.) limited to 60 students; lab (1 cr.) limited to 30 students. Priority given to enology and viticulture students. Letter grades only. K. Arnink and I. Merwin.
An introduction to the study of grape cultivation, fermentation biology, wine composition, and sensory perception. Topics include winemaking history, viticultural regions, current vineyard and winery practices, wine chemistry and microbiology, and sensory evaluation of wine flavors. Wines are used to illustrate the components and processes that determine wine sensory properties.

FD SC 150(1500) Food Choices and Issues
Spring. 2 credits. S-U or letter grades. R. B. Gravani and D. D. Miller.
The goal of this course is to help students develop improved strategies for making healthier food choices. Concepts and principles that form the bases for current dietary guidelines and food safety regulations are discussed. Topics include the U.S. food system, relationships between diet and health, food processing, food safety, and selected contemporary issues relating to nutrition, food quality, and safety. Students conduct nutritional analyses of their diets using a computer software program.

FD SC 200(2000) Introduction to Physicochemical and Biological Aspects of Food (also NS 345[3450])
Fall. 3 credits. Prerequisite: college-level courses in chemistry and biology. Letter grades only. J. H. Hotchkiss and R. S. Parker.
Comprehensive introduction to the physical, chemical, and nutritional properties of foods and to the principles and practice of food

science and technology. Topics include chemistry and functionality of commodities and ingredients, chemical and physical phenomena that affect food quality, techniques of processing and preservation, microbiology and fermentation, food safety, and regulation.

FD SC 210(2100) Food Analysis
Spring. 3 credits. Limited to 24 students. Prerequisite: CHEM 208 or equivalent. Lec, lab. A. Orta-Ramirez.
Introduces basic analytical techniques for food analysis and other biological analysis. Emphasizes fundamental principles of analytical chemistry, basic laboratory techniques, and modern instrumental methods. Discusses gravimetric, volumetric, and spectrophotometric methods, gas chromatography (GC), high-performance liquid chromatography (HPLC), infrared spectra (IR), and atomic absorption spectrometry.

FD SC 250(2500) Kosher and Halal Food Regulations (D)
Spring. 2 credits. Prerequisite: at least sophomore standing. S-U or letter grades. J. M. Regenstein.
Comprehensive introduction to kosher and halal foods in the American food industry with some coverage of home practices. Examines the kosher food laws, their origin, and their application in modern food processing. Describes the nature of the kosher supervision industry in America. Also examines Halal laws and explores the interactions between the two communities. Reviews current food-related issues in both communities, including recent court decisions. May also consider some aspects of ethnic foods.

FD SC 290(2900) Meat Science (also AN SC 290[2900])
Fall. 2 or 3 credits; lec only—2 credits; lec plus lab—3 credits; lab cannot be taken without lec. Letter grades only. D. E. Shaw.
Introduction to meat science through a study of the structure, composition, and function of muscle and its conversion to meat. Also studies properties of fresh and processed meat, microbiology, preservations, nutritive value, inspection, and sanitation. Lab exercises include anatomy, meat-animal slaughter, meat cutting, wholesale and retail cut identification, processing, inspection, grading, quality control, and meat merchandising. An all-day field trip to commercial meat plants may be taken.

FD SC 321(3210) Food Engineering Principles
Fall. 3 credits. Prerequisites: FD SC 200 and introductory physics. Letter grades only. S. S. H. Rizvi.
Introduces the engineering principles underlying food processes and equipment. Topics include thermodynamics, mass and energy balance, fluid mechanics, heat and mass transport, refrigeration and psychrometrics.

FD SC 340(3400) Microbiology and Technology of Winemaking
Fall. 2–3 credits; 2 credits for lec, additional credit for lab. Limited to 30 students (lec), 20 students (lab). Prerequisite: introductory microbiology or permission of instructor. Priority given to enology or viticulture students for whom lab is required. Letter grades only. R. Mira de Orduña.
This course provides a systematic overview of the microbiological technological and organizational fundamentals of winemaking considering differences among winemaking regions.

FD SC 351(3510) Milk Quality
Fall. 1 credit. Prerequisite: AN SC 250 or equivalent or permission of instructor. Letter grades only. M. Wiedmann.
Focuses on the effects of on-farm and animal husbandry practices on milk and dairy food quality and safety. Significant parts of class focus on discussion and critical analysis of the assigned reading materials, questions, and hot topics.

FD SC 394(3940) Applied and Food Microbiology (also BIOMI 394[3940])
Fall. 3 credits. Prerequisites: BIOMI 290–291. C. A. Batt.
Microorganisms play a central role in a variety of food, agricultural, and environmental processes. This course presents a comprehensive survey of the roles that microorganisms play in industrial/biotechnological processes as well as their importance in the safety and production of foods. Reviews issues related to the biochemistry, genetics, and physiology of microorganisms important in these processes. A 2-credit core section on food microbiology is complemented by a 1-credit section on industrial/biotechnological applications.

FD SC 395(3950) Food Microbiology Laboratory
Fall. 2 credits. Prerequisite: BIOMI 291 or equivalent. Letter grades only. A. Orta-Ramirez.
Work includes study of the physiological characteristics of representative food microorganisms, practice in using general and rapid methods for microbiological testing and control of food products, and practice in the application of a systematic approach to controlling the safety of foods, or addressing a food safety issue.

[FD SC 396(3960) Food Safety Assurance
Spring. 2 credits. Prerequisite: BIOMI 290 or permission of instructor. Offered alternate years; next offered 2008–2009. R. B. Gravani.
Provides information on procedures to control biological, chemical, and physical hazards and assure the safety of foods. Topics include discussions on the hazards in foods, good manufacturing practices, prerequisite programs, Hazard Analysis Critical Control Point (HACCP) concept, and the application of current technologies in reducing the risk of foodborne illnesses. Uses case studies and class projects to demonstrate and apply the key principles discussed.]

FD SC 400(4000) Current Topics in Food Science and Technology
Spring. 1 credit. S-U grades only. S. J. Mulvaney and staff.
Discussion of current topics in food science. Topics vary and are chosen from scientific literature and popular press.

[FD SC 401(4010) Concepts of Product Development
Spring. 2 credits. Prerequisite: FD SC 200 or equivalent. Letter grades only. Offered alternate years; next offered 2008–2009. J. H. Hotchkiss.
Discussion of the sequence of events in developing and marketing new food products. Topics include food formulation, packaging and labeling, food additive and ingredient regulations, taste panels, market testing, market research, and patents.]

FD SC 402(4020) Agriculture in Developing Nations I (also IARD 402[4020])
Fall. 2 credits. T. W. Tucker and R. W. Blake (Mexico sec); K. V. Raman and W. R. Coffman (India sec).
Acquaints students with the major issues and problems in international agriculture and rural development and demonstrates how problems in development are being addressed in the Gulf Region of Mexico and India. The lectures/discussions establish the global and regional contexts for sustainable agricultural development and focus on development challenges in Latin America and Asia through cases in southern Mexico and India. This course may be taken as a stand-alone survey course in international agriculture and rural development. However, it is primarily a preparatory course for participants selected to participate in the spring semester course Agriculture in the Developing Nations II (IARD 602), which includes concurrent field trips to the Gulf Region of Mexico and India during the January intersession.

[FD SC 405(4050) Managing Food Waste Without Trashing the Environment
Spring. 2 credits. Prerequisite: FD SC 200 or equivalent. Letter grades only. Lec, lab. Offered alternate years; next offered 2008–2009. J. M. Regenstein.
Examines the various waste streams generated by food plants, institutional feeders, supermarkets, and restaurants. What is the role of waste minimization? What technologies can control or remediate the problems? What are the disposal, composting, and recycling options? What are the legal requirements locally, state-wide, and nationally that affect various food waste processes? This course serves as a general introduction to available waste management technologies and to policy issues faced by a wide range of businesses and production plants.]

FD SC 406(4060) Dairy and Food Fermentations
Fall. 2 credits. Prerequisite: BIOMI 290. Letter grades only. M. Wiedmann.
Lecture course covering the basic principles of fermentation, the microbiology of food fermentations (including the physiology and genetics of fermentative microorganisms), starter cultures and their preparations and applications, as well as specific examples of food fermentations. Selected textbook readings are supplemented with papers from peer-reviewed journals. Significant parts of class focus on discussion and critical analysis of the assigned reading materials.

FD SC 410(4100) Sensory Evaluation of Food
Fall. 2–3 credits; 1 lab credit. Lec and lab required for undergraduate food science majors. Prerequisite: statistics course. Letter grades only. H. T. Lawless.
Topics include the sensory evaluation methods used to test the flavor, appearance, and texture of foods by quantitative description and simple difference testing; consumer testing for product acceptability; sensory tests in quality control; strategic product research; and product development. Presents the psychological principles in sensory testing and statistical methods for sensory data analysis. The lab provides first-hand experience in organizing and conducting sensory tests and an introduction to online date collection and analysis.

FD SC 415(4150) Principles of Food Packaging
Spring. 3 credits. Letter grades only. Offered alternate years. J. H. Hotchkiss.
Discusses the chemical and physical properties and manufacture of the basic materials used to construct packaging. Presents the influence of packaging on shelf life. Emphasizes newer packaging technologies and materials. Briefly presents economics, design, and regulation of food packaging.

FD SC 417(4170) Food Chemistry I
Spring. 3 credits. Prerequisites: CHEM 257 or BIOBM 330 or 331. S-U or letter grades. J. W. Brady.
Covers the chemistry of foods and food ingredients. Discusses the chemical and physical properties of water, proteins, lipids, carbohydrates, and other food components and additives in the context of their interactions and functional roles in foods.

FD SC 418(4180) Food Chemistry II
Fall. 3 credits. Prerequisite: FD SC 417. S-U or letter grades. C. Y. Lee, C. I. Moraru, and J. M. Regenstein.
Discusses the chemical composition of several food groups (meats, fruits, vegetables, and dairy) and describes the chemical reactions and changes that take place during processing and storage, as well their effects on the quality and nutritional characteristics of these foods.

FD SC 419(4190) Food Chemistry Laboratory
Spring. 2 credits. Prerequisites: BIOBM 330 or 331 or CHEM 257 or equivalent. Corequisite: FD SC 417. D. D. Miller.
Deals with the chemical properties of food components and changes they undergo in processing and storage. Stresses relationships between the chemical composition of foods and functional, nutritional, and sensory properties. Introduces lab techniques commonly used in food research. Requires a lab research project that involves writing a research proposal for the project, conducting laboratory research to test hypotheses described in the proposal, analyzing the data, and writing a paper following the format used by the *Journal of Food Science*.

FD SC 423(4230) Physical Principles of Food Preservation and Manufacturing
Fall. 3 credits. Prerequisite: FD SC 321. Letter grades only. Lec, disc. S. J. Mulvaney.
Emphasizes the fundamental principles that underlie much of food preservation and manufacturing. Uses a systems analysis approach to make connections between the chemical and physical changes that occur in food processing and their impact on food quality. Topics include materials properties of foods, heat processing, freezing, concentration, and drying. Selected products serve as case studies for more complex manufactured foods.

FD SC 425(4250) Unit Operations and Dairy Foods Processing
Spring. 3 credits. Prerequisites: FD SC 321, 394, 417, 418, and 423. Letter grades only. Lec, lab. C. I. Moraru.
Combined lecture-laboratory course focusing on principles and practices fundamental to modern dairy foods processing. Structured in two parts. The first part deals with the main unit operations used in dairy processing (i.e., pasteurization, sterilization, centrifugal separation, homogenization, membrane separation, concentration, and drying) and the second part focuses on the science and technology that underpins the manufacture of main classes of dairy products (i.e., fluid milk, milk powder, ice cream, butter, and cheese). Laboratories are conducted in a food processing pilot plant facility, which allows students to gain hands-on experience in operating pilot plant equipment and the manufacture of safe, high quality dairy products. One field trip to operating dairy plants in the area is scheduled during the semester.

FD SC 430(4300) Understanding Wine and Beer
Spring. 3 credits. Prerequisites: introductory biology and chemistry or permission of instructor; age 21 by first day of class (Jan. 22, 2008). Letter grades only. T. E. Acree and K. J. Siebert.
Introduction to wine and beer appreciation through the study of fermentation biology, product composition, and sensory perception. Uses samples of wines and beers to illustrate the sensory properties, microbiological processes, and chemical components that determine quality. Students learn to recognize the major features of wine and beer that determine sensory quality and know the processes that produced them. Topics include the psychology and chemistry of bouquet, taste, and aroma; the microbiology of fermentation and spoilage; the sensory properties of wines from different grape varieties, viticultural practices, and wine-making techniques; and the effects of brewing raw materials and processing procedures on beer quality.

FD SC 440(4400) Wine and Grape Flavor Development
Spring. 3 credits. Limited to 30 students. Prerequisites: FD SC 104 and CHEM 257. Letter grades only. G. Sacks.
This course will use a (bio)-chemical perspective to investigate viticulture and enological factors that impact flavor and other quality attributes (mouthfeel, color, stability) of wine and wine grapes. Course is limited to 30 students, with preference given to students in the enology or viticulture program.

FD SC 450(4500) Fundamentals of Food Law
Spring. 2 credits. Letter grades only. Offered alternate years. J. M. Regenstein.
Introduction to the complex array of federal and state statutes and regulations that control the processing, packaging, labeling, and distribution of food, including aspects of safety and nutritive value. Emphasizes the Food and Drug Administration and U.S. Department of Agriculture regulations but also refers to other regulatory agencies. Emphasizes how a food or agricultural professional interacts with the U.S. legal system during legislative action, regulatory rule making, and with respect to compliance.

[FD SC 456(4560) Advanced Concepts in Sensory Evaluation
Spring. 2 credits. Prerequisite: FD SC 410. S-U or letter grades. Offered alternate years; next offered 2008–2009. H. T. Lawless.
Readings and discussions of primary source materials in sensory evaluation, including recent advances in sensory methods, historical perspectives, psychophysics, perceptual biases, and multivariate statistical approaches to sensory data. Students conduct a research project or term paper on a current issue in sensory evaluation.]

FD SC 480(4800) Global Seminar: Building Sustainable Environments and Secure Food Systems for a Modern World (also NTRES/IARD 480[4800])
Spring. 3 credits. Prerequisite: junior, senior, or graduate standing. J. Lassoie and D. Miller.
Modernization has led to development pressures that have increasingly disrupted natural systems, leading to widespread concerns about the long-term viability of important environmental services, including those critical to food security worldwide. This multidisciplinary course uses case studies to explore interrelationships among social, economic, and environmental factors basic to sustainable development. Cases examine contemporary issues such as population growth, genetically modified foods, biodiversity, sustainable marine fisheries, water quality, global warming, and global responsibility. Cornell faculty members lead discussions in each of the major topic areas. In addition, students participate in discussions and debates with students from Sweden, Costa Rica, Honduras, South Africa, and Australia through live interactive videoconferences and electronic discussion boards.

FD SC 494(4940) Special Topics in Food Science
Fall or spring. 4 credits max. S-U or letter grades. Staff.
The department teaches "trial" courses under this number. Offerings vary by semester, and are advertised by the department before the semester starts. Courses offered under the number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

FD SC 497(4970) Individual Study in Food Science
Fall or spring. 3 credits max. Prerequisite: permission of instructor. Students must register using independent study form (available in 140 Roberts Hall). S-U or letter grades. Staff.
May include individual tutorial study, a special topic selected by a professor or a group of students, or selected lectures of a

course already offered. Since topics vary, the course may be repeated for credit.

FD SC 498(4980) Undergraduate Teaching Experience
Fall or spring. 3 credits max. Prerequisite: permission of instructor. Students must register using independent study form (available in 140 Roberts Hall). S-U grades only. Staff.
Students assist in teaching a course appropriate to their previous training and experience. Students meet with a discussion or laboratory section and regularly discuss objectives with the course instructor.

FD SC 499(4990) Undergraduate Research in Food Science
Fall or spring. 4 credits max; may be repeated for credit. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall). Staff.
Students conduct original research directed by a food science faculty member.

FD SC 599(5990) Research for Lausanne Exchange Students
Fall/spring. 10 credits max. Prerequisite: permission of instructor. S-U or letter grades. Staff.
Undergraduate senior thesis research for Lausanne exchange students only. Students conduct original research directed by a food science faculty member, then write and present a final report to the faculties of both Cornell University and the University of Lausanne.

FD SC 600(6000) Seminar in Food Science
Fall and spring. 1 credit. S-U grades only. Requirement for all graduate students in field of food science and technology; highly recommended for graduate students minoring in food science and technology. Staff.
Weekly seminar series on contemporary topics and issues in the field of food science and technology. Representatives from academia, industry, and government provide presentations on a wide variety of topics. Graduate students in the field of food science and technology may use the forum to present their required thesis research seminar.

FD SC 602(6020) Agriculture in Developing Nations II (also IARD 602[6020])
Spring, field trips to Gulf Region of Mexico (sec 1) and India (sec 2) during Jan. intersession. 3 credits. Prerequisites: IARD 402 and (or) permission of instructors. Cost of field study trip (including airfare, local transportation, and lodging; some merit and need based financial aid may be available): approx. $2,500. R. W. Blake, T. W. Tucker, and C. F. Nicholson (Mexico); K. V. Raman and W. R. Coffman (India).
For description, see IARD 602.

[FD SC 604(6040) Chemistry of Dairy Products
Fall. 2 credits. Limited to 16 students. Prerequisites: introductory organic and biochemistry, food chemistry, and dairy foods processing courses or permission of instructor. Letter grades only. Offered alternate years.
D. M. Barbano.
Detailed study of milk constituents and their properties. Covers the chemical and physical changes that occur in dairy products before, during, and after processing. Emphasizes current research in dairy chemistry.]

FD SC 607(6070) Advanced Food Microbiology
Spring. 2 credits. Prerequisites: BIOMI 290, FD SC 394. Letter grades only. Offered alternate years. M. Wiedmann.
Explores advanced topics in food microbiology. Places major emphasis on critical evaluation of current literature and on microbiological concepts that affect food microbiology. Specific areas covered include microbial ecology of foods, rapid detection and typing methods for foodborne pathogens, microbial modeling, pathogenesis of foodborne diseases, and food applications of genetic engineering. Some guest lectures may be arranged to provide an introduction to other advanced food microbiology topics (e.g., risk assessment).

[FD SC 608(6080) Chemometric Methods in Food Science
Fall. 2 credits. Prerequisites: basic statistics and chemistry course or permission of instructor. S-U or letter grades. Offered alternate years; next offered 2008–2009. K. J. Siebert.
Food science applications using multivariate statistical methods (chemometrics) include extracting information from large data sets, modeling molecular and product properties, optimizing analytical methods and processing operations, discerning relationships between product composition and sensory properties, identifying cultivars or species, and detecting adulteration. The techniques covered are also applicable to many other problems in biology and chemistry.]

FD SC 616(6160) Flavors—Analysis and Applications
Spring. 2 credits. S-U or letter grades. Lec, disc. Offered alternate years. H. T. Lawless and T. E. Acree.
Advanced course in sensory and instrumental analysis of flavors, flavor chemistry, and flavor applications in foods for food scientists and those in related fields concerned with human food perception and consumption. Surveys taste, aroma and volatile flavors, and trigeminal stimuli from the perspectives of chemical structures, methods of analysis, uses and interactions in food systems. Also discusses recent advances in the physiology of taste and smell.

FD SC 620(6200) Food Carbohydrates (also NS 620[6200])
Spring. 2 credits. Prerequisite: qualified seniors and graduate students, BIOBM 330 or equivalent. Offered alternate years. B. A. Lewis and J. W. Brady.
Considers the chemistry of carbohydrates, including sugars, starches, pectins, hemicelluloses, gums, and other complex carbohydrates. Emphasizes the intrinsic chemistry and functionality in food systems and the changes occurring during food processing and storage.

[FD SC 621(6210) Food Lipids
Fall. 2 credits. Prerequisite: basic biochemistry course. Letter grades only. Offered alternate years; next offered 2008–2009. R. H. Liu.
Describes the physical, chemical, biochemical, and functional properties of lipids. Emphasizes lipid oxidation, emulsions, and functional foods associated with lipids.]

FD SC 622(6220) Nutraceuticals and Functional Foods
Fall. 2 credits. Prerequisites: biochemistry course equivalent to BIOBM 330 and one year college biology or permission of instructor. Letter grades only. Offered alternate years. R. H. Liu.
Covers nutraceuticals and functional foods, natural bioactive compounds, antioxidants, and dietary supplements, botanicals and herbs in disease prevention and health promotion. Emphasizes the mechanisms of action and scientific evidence of efficacy of nutraceuticals and functional foods. Also discusses biomarkers, safety and efficacy testing, and regulations for nutraceuticals and functional foods.

FD SC 664(6640) Food Polymer Science: Principles and Applications
Spring. 2 credits. Prerequisites: introductory chemistry and physics. Offered alternate years. S. J. Mulvaney.
Integrates polymer science, chemistry, and materials science principles as the basis for characterization of the physical properties of biopolymer materials of interest to the food industry. Emphasizes unique aspects of food materials, e.g., plasticization by water, physical gelation, transient networks, and effects of thermal treatments on material properties. Problems and case studies based on proteins, starches, gelatin, and other hydrocolloids relevant to food systems.

[FD SC 665(6650) Food and Bioprocessing Systems
Spring. 2 credits. Prerequisite: FD SC 423. Letter grades only. Lec, disc. Offered alternate years; next offered 2008–2009. S. H. Rizvi, S. J. Mulvaney, and C. I. Moraru.
Fundamental and quantitative analyses of current and emerging techniques used in the processing of foods and related biological materials. Topics include thermal processes, extrusion, supercritical fluids processing, membrane separation, high-pressure processing, pulsed electric field processing, ultraviolet and pulsed light treatment.]

FD SC 694(6940) Special Topics in Food Science
Fall or spring. 4 credits max. S-U or letter grades. Staff.
The department teaches "trial" courses under this number. Offerings vary by semester, and are advertised by the department before the semester starts. Courses offered under the number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

FD SC 695(6950) Current Readings in Food Science
Fall and spring. 1 credit; may be taken multiple times. Graduate students in food science strongly encouraged to enroll. Prerequisite: 300- to 400-level course relevant to chosen topic. S-U grades only. Staff.
Seminar series on current topics chosen by participating faculty members and students on a rotating basis. Format consists of weekly discussion groups with each participant presenting at least one oral report based on independent reading. Multiple sections focusing on different topics may be taught in any given semester. Topics include food microbiology and food safety; food chemistry; packaging; food engineering. Interested

students should contact the designated instructor(s) for each semester.

FD SC 698(6980) Graduate Teaching Experience
Fall and spring. 1 to 3 credits. S-U grades only. Staff.
Designed to give graduate students teaching experience through involvement in planning and teaching courses under the supervision of field faculty members. The experience may include leading discussion sections; preparing, assisting in, or teaching lectures and laboratories; and tutoring.

FD SC 800(8000) Master's-Level Thesis Research
Fall or spring. Credit TBA; max. 12. Prerequisite: master's candidates; permission of Special Committee chair. S-U grades only. Graduate faculty.

FD SC 900(9000) Graduate-Level Thesis Research
Fall or spring. Credit TBA; max. 12. Prerequisite: doctoral students who have not passed "A" exam; permission of Special Committee chair. S-U grades only. Graduate faculty.

FD SC 901(9010) Doctoral-Level Thesis Research
Fall or spring. Credit TBA. Maximum of 12 credits. Prerequisite: doctoral students who have passed "A" exam; permission of Special Committee chair. S-U grades only. Graduate faculty.

HORTICULTURE

M. P. Pritts, chair (134A Plant Science Bldg., 255-1778); N. L. Bassuk, R. R. Bellinder, M. P. Bridgen, L. J. Bushway, L. Cheng, P. Cousins, L. E. Drinkwater, M. Eames-Sheavly, S. Gan, M. C. Goffinet, D. E. Halseth, A. N. Lakso, I. A. Merwin, W. B. Miller, J. Mt. Pleasant, K. W. Mudge, C. Owens, A. M. Petrovic, D. A. Rakow, A. Rangarajan, B. I. Reisch, F. S. Rossi, J. E. Vanden Heuvel, C. B. Watkins, T. H. Whitlow, H. C. Wien, D. W. Wolfe

HORT 101(1110) Horticultural Science and Systems
Fall. 4 credits. I. A. Merwin.
Science and technology of horticultural plants grown for foods and beverages and ornamental, landscape, or recreational purposes. Lectures, labs, and field trips involve natural history and evolution of horticultural plants, botany and physiology, sustainable management of soil, water and plant nutrition, breeding and propagation, ecological and landscape functions, and integrated design and management of horticultural plantings and production systems.

HORT 102(1120) Hands-On Horticulture
Spring. 2 credits. Not for plant science majors. Nominal materials fee. M. P. Pritts.
The objective is to instill in students a lifelong appreciation for how gardening can enhance individual well-being through aesthetics, culinary experiences, and mastery of techniques. Emphasizes hands-on learning and practice of key gardening skills and techniques in the greenhouse and the field, such as landscape management, garden design, propagation, pruning, grafting, pest management, and flower arrangement. There is one Saturday field trip at the end of the semester to visit gardens in the local area.

HORT 104(1040) Introduction to Wines and Vines (also FD SC 104[1040])
Spring. 2–3 credits. Letter grades only. K. J. Arnink and I. A. Merwin.
For description, see FD SC 104.

HORT 201(2010) The Art of Horticulture
Fall. 2–3 credits. Fee for materials: $35. M. Eames-Sheavly.
Experiential survey course, two distinct units: plants used in/as art; plants as a subject of art. Unit 1: sculpture methods, such as turf-works, tree sculpture, Unit 2: drawing, botanical illustration, watercolor/pastel painting. Required: attendance; critical reflection in journals; original, creative final project. Optional third credit: pursue proficiency in drawing.

[HORT 215(2150) Sophomore Seminar: Nonfiction Adventure Writing: Reclaiming the Scientist's Voice
Spring. 4 credits. Limited to 15 students. Letter grades only. Next offered 2008–2009. T. H. Whitlow.
Classroom discussion, adventures in the field and lab provide raw material for writing individual narratives.

Sponsored by the John S. Knight Institute's Sophomore Seminars Program.]

HORT 220(2200) Practicing Sustainable Land Care
Fall. 2–3 credits; 1 additional credit for student projects by permission of instructor. Offered odd-numbered years. L. E. Drinkwater.
Experiential course emphasizing interdisciplinary, ecosystem-based approaches to land management and food production. Covers concepts from biological and environmental sciences (i.e., ecology, soil science, horticulture) and includes hands-on activities in organic agriculture, agroforestry, and ecosystem restoration. Classes are held at Dilmun Hill Organic Farm and the MacDaniels Nut Grove.

HORT 235(2350) Plants and Human Well-Being (CA) (HA)
Spring. 3 credits. Offered even-numbered years. J. Mt. Pleasant and S. M. Skelly.
Examines the beneficial effects of plants on human cultures, communities and individuals. Areas of focus include: impacts of community gardens, green space, and farmer's markets; use of plants for pollution control, economic development, conflict resolution, and tourism; how plants benefit individuals, in terms of adult cognition, K–12 education, mental health, and personal empowerment. Laboratories include field trips and exercises to allow students to analyze and evaluate plant-based initiatives in many phases of contemporary life.

HORT 240(2400) Exploring the Small Farm Dream
Spring. 1 credit. Prerequisite: permission of instructors. S-U grades only. J. Green and A. Rangarajan.
Explore opportunities and challenges involved in starting up and managing a small farm. Weekly presentations and discussion with innovative farmers and others. Topics include diversified farming, high-value horticulture, grass-based farming, agroforestry, dairy and livestock opportunities, community-supported agriculture, farm business planning, access to land, marketing strategies, juggling jobs, family-farming, and more.

[HORT 243(2430) Taxonomy of Cultivated Plants (also BIOPL 243[2430])
Fall. 4 credits. Prerequisite: one year introductory biology or written permission of instructor. May not be taken for credit after BIOPL 248. Offered even-numbered years; next offered 2008–2009. M. A. Luckow.
For description, see BIOPL 243.]

HORT 300(3000) Herbaceous Plant Materials
Fall. 3 credits. Cost of field trip: $75. W. B. Miller.
Identification, use, characteristics, and garden cultural requirements of annual and herbaceous perennial plants, especially those used in northern climates. Practical gardening experiences at selected campus locations. Field trips to nearby specialty nurseries.

[HORT 310(3100) Production and Marketing of Greenhouse Crops
Spring. 4 credits. Prerequisites: HORT 101 and any other horticulture course; junior standing preferred. Letter grades only. Cost of required three-day field trip: approx. $130. Offered odd-numbered years; next offered 2008–2009. W. B. Miller.]

HORT 317(3170) Seed Science and Technology (also CSS 317[3170])
Fall. 3 credits. Prerequisite: BIOPL 241 or equivalent course approved by instructor. Letter grades only. Offered odd-numbered years. A. G. Taylor, Geneva Experiment Station.
Study of the principles and practices involved in seed production, conditioning, storage, quality management, seed enhancements, and stand establishment. Information is applicable to various kinds of agricultural and horticultural seeds. Hands-on laboratory experience.

HORT 330(3300) Golf and Sports Turf Management I
Spring. 3 credits. Prerequisite: CSS 260 or permission of instructor. Letter grades only. F. S. Rossi and A. M. Petrovic.
Proposal, siting, specification, installation, establishment, and management of turfgrass areas. Emphasizes commercial locations including lawns, sports fields, and golf courses. Case study projects are a major aspect of the course.

HORT 340(3400) Golf and Sports Turf Management Techniques
Fall. 2 credits. Prerequisite: HORT 330. Letter grades only. F. S. Rossi.
A course designed to provide hands-on learning of essential turfgrass management skills including mower set-up, sprayer calibration, calibration mathematics, budget development, etc.

HORT 391(3910) Woody Plant Identification and Use I
Fall. 2 credits. Limited enrollment. Prerequisite: permission of instructor. Letter grades only. N. L. Bassuk.
Module of HORT/LA 491 covering the identification of approximately 200 woody trees, shrubs, and vines in leaf and their use in the landscape. Students desiring a more comprehensive course that covers site

assessment, soil modification, design, plant specifications and landscape establishment principles and techniques should take HORT/LA 491 or the 491–492 sequence.

HORT 392(3920) Woody Plant Identification and Use II
Spring. 2 credits. Limited enrollment. Prerequisite: permission of instructor. Letter grades only. N. L. Bassuk.
Module of HORT/LA 492 covering the identification of approximately 160 evergreen trees and shrubs and deciduous plants using winter identification. HORT 391 (fall module) need not be taken before taking HORT 392 (spring module). Students also assist in the establishment of a new landscape on campus.

HORT 400(4000) Principles of Plant Propagation
Spring. 3 credits. Prerequisites: BIOPL 242 and 244 or another plant physiology course or permission of instructor. K. W. Mudge.
Asexual (vegetative) propagation including cuttage, graftage, tissue culture, layering, and specialized vegetative reproductive structures and sexual (seed) propagation. Stresses physiological, environmental, and anatomical principles and industry applications in lecture, and hands-on skills in laboratories. Examples include both temperate and tropical horticultural, agronomic, and forestry crops.

HORT 420(4200) Nursery-Crop Production
Fall. 3 credits. Prerequisite: HORT 400 or permission of instructor. Cost of field trips: $75. Offered odd-numbered years. K. W. Mudge.
Principles and practices of commercial nursery crop production. Term project required. Includes field trips to commercial nurseries.

HORT 425(4250) Postharvest Biology of Horticultural Crops
Fall. 3 credits. Offered odd-numbered years. S. Gan.
Study of the biological processes controlling physical and chemical changes in harvested yet living horticultural crops or their parts. Discusses the theoretical principles and fundamental processes underlying these changes. Also covers strategies and practical handling requirements/conditions for storage, transportation, and quality monitoring of harvested horticultural crops.

[HORT 426(4260) Practicum in Forest Farming as an Agroforestry System (also NTRES/CSS 426[4260])
Fall. 2 credits. Prerequisite: junior, senior, or graduate standing or permission of instructor. Offered even-numbered years; next offered 2008–2009. K. W. Mudge, P. Hobbs, and L. E. Buck.
Students actively take part in the restoration of a 70-year-old nut grove. Outdoor activities are integrated with readings via an online discussion board.]

[HORT 435(4350) The Care of Woody and Herbaceous Plants in the Landscape
Fall. 3 credits. Prerequisites: HORT 300 and 491 or permission of instructor. Cost of required field trip: $75. Letter grades only. Offered even-numbered years; next offered 2008–2009. Staff.
Study of the practices involved in the maintenance of ornamental plants in the landscape. Labs have a hands-on focus.]

[HORT 440(4400) Restoration Ecology
Fall. 5 credits. Prerequisite: upper division or graduate standing and permission of instructor. Letter grades only. Lec, lab, plus several weekends. Next offered 2008–2009. T. H. Whitlow.
Draws concepts from ecology, hydrology, soil science, and conservation biology and applies these in both principle and practice to the evolving field of restoration ecology.]

[HORT 442(4420) Berry Crops: Culture and Management
Fall. 3 credits. Offered even-numbered years; next offered 2008–2009. M. P. Pritts.
Study of the evolution, breeding history, and physiology of strawberries, raspberries, blackberries, and blueberries, and of cultural practices that influence productivity, fruit quality, and pest damage.]

HORT 443(4430) Viticulture and Vineyard Management—I
Fall. 3 credits. Prerequisites: BIO G 101/103, 102/104, BIOPL 241, CSS 260, BIOPL 242/244 or equivalents. Letter grades only. J. E. Vanden Huevel, M. C. Goffinet, and A. N. Lakso.
First-semester course in commercial grape production with an emphasis on the problems of production in cold climates. Students examine environmental factors favoring production and quality, soils, and the anatomical and physiological basis for vineyard management decision-making. Laboratory exercises and field trips offer hands-on experience.

HORT 444(4440) Viticulture and Vineyard Management—II
Spring. 3 credits. Pre- or corequisites: HORT 443 and PL BR 225 or equivalent. Letter grades only. J. E. Vanden Heuvel, B. I. Reisch, P. Cousins, and C. Owens.
Second-semester course in commercial grape production with an emphasis on the problems of production in cold climates. Students examine the genetics of the vine, and learn principles of vineyard establishment, propagation, pruning and training, and conservation. Laboratory exercises and field trips offer hands-on experience.

HORT 445(4450) Ecological Orchard Management
Spring. 3 credits. Prerequisite: introductory biology. Recommended: previous horticulture/plant science courses. S-U or letter grades. Offered even-numbered years. I. A. Merwin.
The ecology and technology of deciduous tree-fruit production. Topics include basic tree and fruit physiology; orchard renovation and design systems; nutrition, irrigation, and freeze protection practices; tree pruning and training; post-harvest fruit storage; marketing and economic spreadsheet models; monitoring and decision-making systems for integrated pest management; and efficient use of orchard equipment. Emphasizes the agroecology of perennial crop systems, with labs providing hands-on experience in orchard management.

HORT 449(4490) Green Signals and Triggers—The Plant Hormones (also BIOPL 449[4490])
Spring. 2 credits. Prerequisites: introductory biology and BIOPL 242 or 342 or permission of instructor. S-U or letter grades. Offered even-numbered years. P. J. Davies.
For description, see BIOPL 449.

[HORT 450(4500) Principles of Vegetable Production
Fall. 3 credits. Prerequisite: HORT 101, CSS 260, or equivalent. Letter grades only. Two Sat. field trips; students responsible for cost of their meals. Offered even-numbered years; next offered 2008–2009. R. R. Bellinder and S. Reiners.
Commercial vegetable production from variety selection to postharvest. Topics include: crop physiology and culture, soil and pest management, stand establishment, marketing, and history of production.]

HORT 455(4550) Mineral Nutrition of Crops and Landscape Plants (also CSS 455[4550])
Spring. 3–5 credits. Prerequisite: CSS 260 and BIOPL 242, or equivalent. Offered even-numbered years. H. C. Wien and staff.
Modular course on principles of plant mineral nutrition and nutrient management. A mandatory module on principles is followed by others on agronomic crops, vegetables, floriculture, and fruit crops. Each module carries 1 credit; a minimum of 3 credits must be taken in one semester. By the end of the course, students understand the principles of mineral nutrient function in crop plants, are able to diagnose deficiencies by symptoms and tissue tests, and can devise organic and conventional nutrient management schemes that maximize productivity and mineral nutrient quality.

HORT 460(4600) Cropping Systems Ecology
Spring. 3 credits. Prerequisite: any crop production or plant ecology course or permission of instructor. Offered even-numbered years. D. W. Wolfe.
Course utilizes the basic principles of plant population biology, environmental physiology, and ecology to evaluate the management, productivity, and environmental impact of various cropping systems. Emphasis is on agricultural systems, but the role of plant–plant interactions and biodiversity in succession and productivity of natural ecosystems will also be discussed.

[HORT 462(4620) Physiology of Vegetables and Flowers
Spring. 4 credits. Prerequisite: BIOPL 242 or equivalent. Offered odd-numbered years; next offered 2008–2009. H. C. Wien.
Study of the physiological principles that govern growth, development, and production of reproductive structures of vegetable crops and herbaceous ornamental plants.]

HORT 466(4660) Soil Ecology (also CSS 466[4660])
Spring. 4 credits, with lab. Prerequisite: one year of biology or ecology and CSS 260 or permission of instructor. J. E. Thies.
For description, see CSS 466.

[HORT 473(4730) Ecology of Agricultural Systems (also BIOEE 473[4730])
Fall. 3 credits. Prerequisite: BIOEE 261 or permission of instructor. S-U or letter grades. During first six weeks, R meetings may run later due to field trips. Next offered 2008–2009. L. E. Drinkwater and A. G. Power.
For description, see BIOEE 273.]

HORT 480(4800) Plantations Lecture Series
Fall, 12 weeks, 6 lec. 1 credit. S-U grades only. Meets alternate W evenings. D. A. Rakow.
Covers a range of subjects related to the plant and natural sciences, and human-cultural themes. On non-lecture Wednesdays, the class meets to discuss content from the previous week. Students are required to write a reaction paper for each lecture.

HORT 485(4850) Public Garden Management
Spring. 3 credits. Prerequisites: HORT 300; HORT 491 or 492. Cost of two-and-a-half-day field trip to botanical gardens and arboreta: approx. $85. Offered even-numbered years. D. A. Rakow and S. M. Skelly.
Explores the history of public gardens, types of contemporary public gardens, and the operation of public gardens including botanical gardens and arboreta. Includes separate units on: administration and business management of gardens, collections curation, collections design, educational programs, research, and management of landscapes and natural areas.

HORT 490(4900) Golf and Sports Turf Management II
Spring. 2 credits. Prerequisite: HORT 330. F. S. Rossi.
Designed for students familiar with turfgrass science and a strong interest in the design, construction, and maintenance of golf courses and sports fields. This course focuses on current and emerging issues concerning the scientific, economic and environmental aspects of golf courses and sports fields.

HORT 491(4910) Creating the Urban Eden: Woody Plant Selection, Design, and Landscape Establishment (also LA 491[4910])
Fall. 4 credits. Limited to 48 students. Prerequisite: horticulture or landscape architecture majors or permission of instructor. Preregistration required. N. L. Bassuk and P. J. Trowbridge.
Focuses on the identification, uses, and establishment of woody plants in urban and garden settings. By understanding the environmental limitations to plant growth, students can critically assess potential planting sites, select appropriate trees, shrubs, vines, and ground covers for a given site, and learn about the principles and practices of site amelioration and plant establishment. Design followed by written specifications and graphic details is produced to implement these practices. A project where students implement what they have learned by creating a new landscape serves to integrate theory, principles, and practices. No prior design experience necessary.

HORT 492(4920) Creating the Urban Eden: Woody Plant Selection, Design, and Landscape Establishment (also LA 492[4920])
Spring. 4 credits. Limited to 48 students. Prerequisite: passing grade in HORT/LA 491; horticulture or landscape architecture majors or permission of instructors. Preregistration required. N. L. Bassuk and P. J. Trowbridge.
Second half of course focusing on the winter identification, uses, and establishment of woody plants in urban and garden settings. Issues of site assessment and soil remediation are emphasized in addition to soil volume calculations, drainage and surface detailing, and planting techniques. Students critically assess potential planting sites, and select appropriate trees, shrubs, vines, and ground covers for a given site. Design for specific sites followed by written specifications and graphic details are produced to implement these proposals. Students implement, in a hands-on manner, site remediation and planting techniques they have learned by creating new landscapes that serve to integrate theory, principles, and practices. Together, HORT/LA 491 and 492 constitute an integrated course.

HORT 494(4940) Special Topics in Horticulture
Fall or spring. 4 credits max. S-U or letter grades. Staff.
The department teaches "trial" courses under this number. Offerings may vary by semester, and will be advertised before the semester begins. Courses offered under the number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

HORT 495(4950) Undergraduate Seminar—Current Topics in Horticulture
Fall and spring. 1 credit; may be taken four times for 1 credit per semester. Graduate students should enroll in HORT 600. S-U grades only. L. Cheng.
Undergraduate participation in weekly departmental seminar series.

HORT 496(4960) Internship in Horticulture
Fall or spring. Variable credit. Prerequisite: permission of student's advisor **in advance of participation** in internship programs. S-U or letter grades. Students must register using individual study form (available in 140 Roberts Hall) signed by faculty member who will supervise study and assign grade. Staff.

HORT 497(4970) Individual Study in Horticulture
Fall or spring. Variable credit. Prerequisite: permission of instructor(s). S-U or letter grades. Students must register using individual study form (available in 140 Roberts Hall).
Individual study in horticultural sciences under the direction of one or more faculty members. Staff.

HORT 498(4980) Undergraduate Teaching Experience
Fall or spring. Variable credit. Prerequisites: previous enrollment in course to be taught or equivalent, and written permission of instructor. S-U or letter grades. Students must register using individual study form (available in 140 Roberts Hall). Staff.
Designed to give qualified undergraduate students teaching experience through actual involvement in planning and teaching horticultural sciences courses under the supervision of departmental faculty members. May include leading discussion sections; preparing, assisting in, or teaching laboratories; and tutoring.

HORT 499(4990) Undergraduate Research
Fall or spring. Variable credit. Prerequisite: permission of instructor. S-U or letter grades. Students must register using individual study form (available in 140 Roberts Hall.) Staff.
Undergraduate research projects in horticultural sciences.

HORT 500(5000) Master of Professional Studies (Agriculture) Project
Fall or spring. 1–6 credits; 6 credits max. toward M.P.S. (agriculture) degree. Requirement for M.P.S. (agriculture) candidates in respective graduate fields of horticulture. S-U or letter grades. Staff.
Comprehensive project emphasizing the application of principles and practices to professional horticultural teaching, extension, and research programs and situations.

HORT 600(6000) Seminar in Horticulture
Fall and spring. 1 credit. Requirement for graduate students majoring or minoring in horticulture. Undergraduate students enroll in HORT 495. S-U grades only. L. Cheng.
Weekly seminars consisting of graduate student research project reports, faculty research topics, as well as guest speakers from other universities and/or industry.

HORT 610(6100) Extension Volunteer Development in Garden-based Learning
Fall. 2 credits. Prerequisite: course work in horticulture and related fields. Undergraduate plant sciences students by permission of instructor. L. J. Bushway.
An extension/outreach training course for graduate entomology, pathology, and horticulture students. Learn the skills to effectively develop the knowledge of adult volunteers in garden-based learning programs. With guidance, develop and pilot a volunteer training session on an introductory horticultural science topic appropriate to your interest and experience.

HORT 611(6110) Field Experience in Extension Volunteer Development in Garden-based Learning
Spring. 1 credit. Prerequisite: HORT 610. L. J. Bushway.
Lead introductory horticultural science training sessions for Master Gardener Volunteers and/or other volunteer groups associated with garden-based learning outreach. Performance reflection discussions with peers and instructor will follow each volunteer training session to facilitate further skill development. Travel to multiple Cornell

Cooperative Extension county offices throughout the state is required.

HORT 615(6150) Quantitative Methods in Horticultural Research
Spring, weeks 1–7. 2 credits. Prerequisite: BTRY 601, 602, or permission of instructor. S-U grades only. Offered even-numbered years. D. W. Wolfe.
Provides experience in applying statistics principles to real-world agricultural research problems. Uses examples of lab, greenhouse, and field studies from the published literature. Explores other quantitative methods. Topics include approaches to controlling and analysis of variation; common block and incomplete block designs; selecting an appropriate significance level; designing on-farm experiments and demonstration plots; regression methods in relation to mechanistic models and path and principal components analysis; and plant growth analysis techniques.

[HORT 617(6170) Advanced Analytical Methods for Plant Systems
Spring. 2 credits. Prerequisite: one year of general chemistry, one semester of organic chemistry, plant physiology. Letter grades only. Offered odd-numbered years; next offered 2008–2009. L. Cheng.
Principles and practical applications of selected laboratory methods in the plant and environmental sciences. Emphasizes enhancement of laboratory technique and problem-solving skills.]

[HORT 618(6180) Breeding for Pest Resistance (also PL BR 618[6180])
Fall. 2 credits. Prerequisites: BIOGD 281 and PL BR 403 or equivalents. Highly recommended: introductory plant pathology and/or entomology course. Letter grades only. Offered even-numbered years; next offered 2008–2009. P. D. Griffiths.
For description, see PL BR 618.]

[HORT 625(6250) Advanced Postharvest Biology
Fall. 1–3 credits, variable. Offered even-numbered years; next offered 2008–2009. Coordinators: S. Gan and C. B. Watkins.]

Sec 01 Advanced Postharvest Physiology. 1 credit. (12 lec). S. Gan.
Emphasizes the physiological and biochemical aspects of growth and maturation, ripening, and senescence of harvested horticultural plant parts.

Sec 02 Plant Senescence (also BIOPL 483.06). 1 credit. (12 lec). S. Gan.
Introduces molecular, genetics, and genomics approaches in plant senescence and postharvest research.

Sec 03 Advanced Postharvest Technology. 1 credit. (12 lec). C. B. Watkins.
Emphasizes advanced existing and emerging technology and practice for handling, monitoring, and storage of horticultural crops after harvest.]

[HORT 635(6350) Tools for Thought
Fall. 1 credit. Prerequisite: graduate standing. S-U grades only. Next offered 2008–2009. T. H. Whitlow.
Discusses readings from Kuhn, Waddington, Wilson, Lewontin, and others emphasizing application of the philosophy of science to the real-world practices of scientists.]

[HORT 640(6400) New Directions in Public Horticulture
Spring. 1 credit. Offered odd-numbered years; next offered 2008–2009. D. A. Rakow and S. M. Skelly.
Designed to introduce students to a range of current issues facing public gardens through a set of required readings. Discussions based on readings and personal experiences.]

HORT 645(6450) Advanced Viticultural Topics
Spring. 2 credits. Prerequisite: HORT 443 or equivalent. Letter grades only. A. N. Lakso and T. R. Bates.
In-depth lecture/discussion of complex topics of viticulture that have important impacts on fruit composition and wine quality. Topics include crop load effects, canopy management, water relations, vineyard efficiency, and vineyard variability/precision viticulture.

HORT 694(6940) Special Topics in Horticulture
Fall or spring. 4 credits max. S-U or letter grades. Staff.
The department teaches "trial" courses under this number. Offerings vary by semester and are advertised by the department before the semester starts. Courses offered under the number will be approved by the department curriculum committees, and the same course is not offered more than twice under this number.

HORT 700(7000) Graduate Teaching Experience
Fall or spring. Variable credit. Prerequisite: permission of instructor; graduate standing. Undergraduates should enroll in HORT 498. S-U or letter grades. Staff.
Designed to give graduate students teaching experience through involvement in planning and teaching courses under the supervision of departmental faculty members. May include leading discussion sections; preparing, assisting in, or teaching lectures and laboratories; and tutoring.

HORT 800(8000) Thesis Research, Master of Science
Fall or spring. Variable credit. S-U grades only.

HORT 900(9000) Thesis Research, Doctor of Philosophy
Fall or spring. Variable credit. S-U grades only.

INTERNATIONAL AGRICULTURE AND RURAL DEVELOPMENT

IARD 300(3000) Perspectives in International Agriculture and Rural Development
Fall. 2 credits. R. Nelson, R. Herdt, and L. Harrington.
Forum to discuss both contemporary and future world food issues and the need for an integrated, multidisciplinary team approach in helping farmers and rural development planners adjust to the ever-changing food needs of the world.

IARD 402(4020) Agriculture in Developing Nations I (also FD SC 402[4020])
Fall. 2 credits. T. W. Tucker and R. W. Blake (Mexico sec); K. V. Raman and W. R. Coffman (India and Thailand sec).
Acquaint students with the major issues and problems in international agriculture and rural development and to demonstrate how problems in development are being addressed in the Gulf Region of Mexico, India, and Thailand. The lectures/discussions establish the global and regional contexts for sustainable agricultural development and focus on development challenges in Latin America and Asia through cases in southern Mexico, India, and Thailand. This course may be taken as a stand-alone survey course in international agriculture and rural development. However, it is primarily a preparatory course for participants selected to participate in the spring semester course Agriculture in the Developing Nations II (IARD 602), which includes concurrent field trips to the Gulf Region of Mexico and India/Thailand during the January intersession.

IARD 403(4030) Traditional Agriculture in Developing Countries (also CSS 403[4030])
Fall. 1 credit. S-U grades only. P. Hobbs.
Today, perhaps more than half of the world's arable land is farmed by traditional farmers. They developed sustainable agriculture practices that allowed them to produce food and fiber for millennia with few outside inputs. Many of these practices have been forgotten in developed countries but are still used by many traditional, subsistence, or partially subsistence farmers in developing countries. This course examines traditional systems from several disciplinary points of view.

IARD 404(4040) Crop Evolution, Domestication, and Diversity [also PL BR/BIOPL 404(4040)]
Spring. 2 credits. Prerequisite: BIOGD 281 or PL BR 225 or permission of instructor. S-U or letter grades. S. Kresovich.
Evolution, domestication, and breeding of crop plants have molded the current diversity we conserve and use. Based on advances in systematics and molecular genetics, this course presents an integrated approach to understanding and describing diversity of agricultural and horticultural species. Underlying ethical, legal, and social issues affecting conservation and use also are addressed.

IARD 405(4050) Patents, Plants, and Profits: Intellectual Property Management for Scientists and Entrepreneurs (also PL BR 405[4050])
Spring. 2 credits. Prerequisite: senior or graduate standing. S-U or letter grades. A. F. Krattiger and S. Kowalski.
For description, see PL BR 612.

IARD 414(4140) Tropical Cropping Systems: Biodiversity, Social, and Environmental Impacts (also CSS 414[4140])
Fall. 3 credits. Prerequisite: introductory crop science, soil science, or biology course or permission of instructor. P. Hobbs.
Characterization and discussion of traditional shifting cultivation, lowland rice-based

systems, upland cereal-based systems, smallholder mixed farming including root crops and livestock, plantation fruit and oil crop systems, and agroforestry. In addition to species diversity and domestication, factors such as climate, land quality, soil management, land tenure, labor, and markets are considered. Evaluates the effect of tropical cropping systems on the environment.

IARD 480(4800) Global Seminar: Building Sustainable Environments and Secure Food Systems for a Modern World (also NTRES/FD SC 480[4800])
Spring. 3 credits. Prerequisite: junior, senior, or graduate standing. Letter grades. J. Lassoie and D. Miller.
For description, see NTRES 480.

IARD 494(4940) Special Topics in International Agriculture (also IARD 694[6940])
Fall, spring, summer. 1–3 credits. S-U or letter grades. Staff.
The department teaches "trial" courses, and special topics not covered in other courses, at the undergraduate level, under this number. Offerings vary by semester, and will be advertised by the department. Courses offered under the number are approved by the department curriculum committee, and the same course is not offered more than twice under this number.

IARD 496(4960) International Internship
Fall, spring. 1–6 credits. Prerequisite: submission of approved internship form (see CALS internship policy guidelines). S-U or letter grades. Staff.
International internship, supervised by a faculty member who is directly involved in determining both the course content and in evaluating a student's work. The student researches and initiates an appropriate international internship and negotiates a learning contract with the faculty supervisor, stating the conditions of the work assignment, supervision, and reporting.

IARD 497(4970) Independent Study in IARD
Fall and spring. 1–3 credits. Prerequisite: permission of instructor. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall). Staff.
Allows students the opportunity to investigate special interests that are not treated in regularly scheduled courses. The student develops a plan of study to pursue under the direction of a faculty member.

IARD 598(5980) International Development M.P.S. Project Paper
Fall and spring. 1–6 credits; max. 6 credits may be applied toward M.P.S. degree. Prerequisite: M.P.S. candidates in field of international development (ID). S-U grades only. N. Uphoff.
Problem-solving project entailing either fieldwork and/or library work. The aim of the project is to give students supervised experience in dealing intellectually and analytically with a professional problem related to a substantive area of international development.

IARD 599(5990) International Agriculture and Rural Development M.P.S. Project Paper
Fall and spring. 1–6 credits; maximum of 6 credits may be applied toward M.P.S. degree requirements. Prerequisite: M.P.S. candidates in field of international agriculture and rural development (IARD). S-U grades only. S. Kyle.
Problem-solving project entailing either fieldwork and/or library work. The aim of the project is to give students supervised experience in dealing intellectually and analytically with a professional problem related to a substantive area of international agriculture and rural development.

IARD 602(6020) Agriculture in Developing Nations II (also FD SC 602[6020])
Spring, field trips to Gulf Region of Mexico (sec 1) and India/Thailand (sec 2) during Jan. intersession. 3 credits. Prerequisites: IARD 402 and (or) permission of instructors. Cost of field-study trip (including airfare, local transportation, and lodging; some merit and need-based financial aid may be available): approx. $2,800 for Mexico section and $4,000 for India/Thailand section. R. W. Blake, T. W. Tucker and C. F. Nicholson (Mexico); K. V. Raman and W. R. Coffman (India).
Designed to provide students with an opportunity to observe agricultural development in tropical Mexico or Asia and to promote interdisciplinary exchange among faculty, staff, students and their Mexican, Indian, and Thai counterparts. A two-week field-study trip in January (three weeks for the India/Thailand section) is followed by discussions, written projects and oral presentations dealing with problems in food, agriculture and livestock production in the context of social and economic conditions of the Gulf Region of Mexico, India, and Thailand.

IARD 603[6030] Planning and Management of Agriculture and Rural Development (also GOVT 692[6927])
Spring. 4 credits. N. T. Uphoff and T. W. Tucker.
Reviews experience and approaches in agricultural and rural development in a range of developing countries, with particular attention to contemporary issues of participation, decentralization, local institutions, capacity-building, civil society, social capital, and empowerment. Case studies from Asia, Africa, and Latin America.

IARD 620(6200) Rural Livelihoods and Biological Resources: Technologies and Institutions
Fall, spring. 1–2 credits. S-U grades only. Biweekly. C. Barrett and A. Pell.
Seminar exploring issues that straddle the boundaries of the biological and social sciences as they relate to rural livelihoods, food security, and the management of biological resources. Students taking the 1-credit option participate in seminars and panels. Students taking the 2-credit option must also participate in a group project.

IARD 685(6850) Training and Development: Theory and Practice (also EDUC 685[6850])
Spring. 4 credits. S-U or letter grades. M. Kroma.
Analysis, design, and administration of training programs for the development of human resources in small-farm agriculture, rural health and nutrition, literacy as nonformal education, and general community development. Designed for scientists, administrators, educator-trainers, and social organizers in rural and agricultural development programs in the United States and abroad.

IARD 694(6940) Graduate Special Topics in IARD
Fall or spring. 1–4 credits. S-U or letter grades. Staff.
The department teaches "trial" courses under this number. Offerings vary by semester and are advertised by the department before the semester starts. Courses offered under the number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

IARD 696(6960) Agroecological Perspectives for Sustainable Development (also NTRES/CSS 696[6960])
Fall, spring. 1 credit. S-U grades only. L. Fisher, L. Buck, and S. DeGloria.
A variety of speakers present seminars on agroecological topics relating to sustainable development throughout the world. Students are required to prepare a synopsis of each seminar.

IARD 697–698(6970–6980) International Development M.P.S. Seminar
Fall, spring. 1 credit. S-U grades only. N. Uphoff.
For M.P.S. students to discuss important issues in international development and to prepare them to write their project papers. Specific content varies.

IARD 699(6990) International Agriculture and Rural Development M.P.S. Project Seminar
Fall, spring. 1 credit. Prerequisite: required for, and limited to, M.P.S. IARD students or permission of instructor. S-U grades only. S. C. Kyle.
Provides students with the opportunity to develop and present their special projects. Also serves as a forum for discussion of current issues in low-income agricultural and rural development, with particular attention to interdisciplinary complexities.

IARD 783(7830) Farmer-Centered Research and Extension (also EDUC 783[7830])
Fall. 3 credits. S-U or letter grades. M. Kroma and T. Tucker.
Introduction to participatory traditions in farming systems research, extension, evaluation of rural development, technology generation, gender analysis, participatory rural appraisal, and documentation of local and indigenous knowledge of community-based development. Case studies of farmer-centered research and extension provide a focus for analysis. Appropriate roles of researchers and extensionists as partners with farmers are examined. A major contribution of farmer-centered research and extensions is its potential to legitimize people's knowledge by enhancing their capacity to critically analyze their own problems, to conduct their own research, and to empower them to take direct action to solve those problems.

Related Courses in Other Departments

In addition to international agriculture and rural development (IARD) courses, many other courses have an international focus. The following are suggested relevant courses:

Applied Economics and Management

International Trade and Finance (AEM 230)

*International Agribusiness Study Trip (AEM 329)

International Trade Policy (AEM 430)

*Food Marketing Colloquium (AEM 446/447)

Global Marketing Strategy (AEM 449)

Seminar on International Trade Policy: Agriculture, Resources, and Development (AEM 730)

Agriculture and Life Sciences

Global Seminar (NTRES 480/FD SC 480/IARD 480)

Animal Science

Livestock in Tropical Farming Systems (AN SC 400)

Tropical Forages (AN SC 403)

Asian Studies

Southeast Asia Seminar: Country Seminar (ASIAN 601)

Biology

Biology of the Neotropics (BIOEE 405)

Food, Agriculture, and Society (BIOEE 469)

The Healing Forest (BIOPL 348)

City and Regional Planning

Seminar in International Planning (CRP 671)

Seminar in Project Planning in Developing Countries (CRP 675)

Crop and Soil Science

Properties and Appraisal of Soils of the Tropics (CSS 471)

Tropical Cropping Systems (CSS/IARD 314)

Development Sociology

Comparative Issues in Social Stratification (D SOC 370)

Education, Inequality, and Development (D SOC 305)

International Development (D SOC 205)

Population Dynamics (D SOC 201)

Social Indicators, Data Management, and Analysis (D SOC 213)

Sociological Theories of Development (D SOC 606)

Education

Farmer-Centered Research and Extension (EDUC/IARD 783)

Natural Resources

Global Ecology and Management (NTRES 322)

Environmental Governance (NTRES 331)

International Conservation: Communities and the Management of the World's Natural Resources (NTRES 434)

Seminar in Ecoagriculture (NTRES 694)

Nutritional Science

Nutritional Problems in Developing Nations (NS 306)

Integrating Food Systems and Human Needs (NS 380)

National and International Food Economics (NS 457)

International Nutrition Problems, Policy, and Programs (NS 680)

Plant Breeding

Plants, Genes, and Global Food Production (PL BR 201)

Crop Evolution, Domestication, and Diversity (PL BR 404)

*Includes overseas travel

INFORMATION SCIENCE

C. Cardie, director; J. Abowd, W. Y. Arms, G. Bailey, K. Bala, M. Barazangi, L. Blume, R. Caruana, R. Constable, D. Easley, S. Edelman, E. Friedman, G. Gay, J. Gehrke, T. Gillespie, P. Ginsparg, C. Gomes, J. Halpern, J. Hancock, A. Hedge, D. Huttenlocher, T. Joachims, J. Kleinberg, L. Lee, A. E. Leiponen, B. Lust, M. Macy, P. Martin, T. Pinch, R. Prentice, M. Rooth, D. Seber, B. Selman, P. Sengers, D. Shmoys, M. Spivey, D. Strang, E. Tardos, E. Wagner, J. Walther, S. Wicker, D. Williamson, C. Yuan

INFO 130(1300) Introductory Design and Programming for the Web (also CS 130[1300])
Fall. 3 credits.
For description, see INFO 130 in CIS section.

[INFO 172(1700) Computation, Information, and Intelligence (also COGST 172, CS 172[1700], ENGRI 172[1700])
Fall. 3 credits. Prerequisites: some knowledge of differentiation; permission of instructor for students who have completed equivalent of CS 100. Next offered 2008–2009.
For description, see CS 172 in CIS section.]

INFO 204(2040) Networks (also CS 285[2850], ECON 204[2040], SOC 204[2120]) (SBA)
Spring. 4 credits.
For description, see ECON 204.

INFO 214(2140) Cognitive Psychology (also COGST/PSYCH 214[2140]) (KCM)
Fall. 4 credits. Limited to 175 students. Prerequisite: sophomore standing. Graduate students: see INFO 614, PSYCH 614, or COGST 501.
For description, see PSYCH 214.

INFO 230(2300) Intermediate Design and Programming for the Web (also CS 230[2300])
Spring. 3 credits. Prerequisite: CS/INFO 130 or equivalent.
For description, see INFO 230 in CIS section.

INFO 245(2450) Psychology of Social Computing (also COMM 245[2450]) (SBA)
Fall. 3 credits.
For description, see COMM 245.

[INFO 292(2921) Inventing an Information Society (also AM ST 292[2980], ECE/ENGRG 298[2980], HIST 292[2920], S&TS 292[2921])

INFO 295(2950) Mathematical Methods for Information Science
Fall. 4 credits. Corequisite: MATH 231 or equivalent.
For description, see INFO 295 in CIS section.

INFO 320(3200) New Media and Society (also COMM 320[3200]) (CA)
Spring. 3 credits.
For description, see COMM 320.

INFO 330(3300) Data-Driven Web Applications (also CS 330[3300])
Fall. 3 credits. Prerequisites: CS/ENGRD 211.
For description, see INFO 330 in CIS section.

INFO 345(3450) Human–Computer Interaction Design (also COMM 345[3450]) (SBA)
Spring. 3 credits.
For description, see COMM 345.

INFO 349(3491) Media Technologies (also COMM 349[3490], S&TS 349[3491]) (CA)
Spring. 3 credits.
For description, see COMM 349.

INFO 355(3551) Computers: From the 17th Century to the Dot.com Boom (also S&TS 355[3551])
Fall. 4 credits.
For description, see S&TS 355.

[INFO 356(3561) Computing Cultures (also S&TS 356[3561]) (CA)]

INFO 366(3650) History and Theory of Digital Art (also ART H 366[3650]) (CA)
Fall. 4 credits.
For description, see ART H 366.

INFO 372(3720) Explorations in Artificial Intelligence (also CS 372[3700])
Spring. 3 credits. Prerequisites: MATH 111 or equivalent, information science approved statistics course, and CS/ENGRD 211 or permission of instructor.
For description, see INFO 372 in CIS section.

[INFO 387(3871) The Automatic Lifestyle: Consumer Culture and Technology (also S&TS 387[3871])
Spring. 4 credits. Next offered 2008–2009.
For description, see S&TS 387.]

INFO 415(4150) Environmental Interventions (also S HUM 415)
Fall. 4 credits.
For description, see S HUM 415.

INFO 429(4290) Copyright in the Digital Age (also COMM 429[4290]) (CA)
Fall. 3 credits.
For description, see COMM 429.

INFO 430(4300) Information Retrieval (also CS 430[4300])
Fall. 3 credits. Prerequisite: CS/ENGRD 211 or equivalent.
For description, see INFO 430 in CIS section.

INFO 431(4302) Web Information Systems (also CS 431[4310])
Spring. 3 credits. Prerequisites: CS/ENGRD 211 and some familiarity with web site technology.
For description, see INFO 431 in CIS section.

INFO 435(4350) Seminar on Applications of Information Science (also INFO 635[6350])
Spring. 3 credits. Prerequisites: background in computing, data structures, and programming at level of CS/ENGRD 211 or equivalent; experience in using information systems.
For description, see INFO 435 in CIS section.

INFO 440(4400) Advanced Human–Computer Interaction Design (also COMM 440[4400]) (SBA)
Fall. 3 credits. Prerequisite: COMM/INFO 245.
For description, see COMM 440.

[INFO 444(4144) Responsive Environments (also ART H 444[4144]) (CA)
Spring. 4 credits. For offering information, see ART H 444.
For description, see ART H 444.]

INFO 445(4450) Seminar in Computer-Mediated Communication (also COMM 445[4450]) (SBA)
Fall. 3 credits. Prerequisite: COMM/INFO 245.
For description, see COMM 445.

INFO 447(4470) Social and Economic Data (also ILRLE 447[4470])
Spring. 4 credits. Prerequisites: one semester of calculus, IS statistics requirement, at least one upper-level social science course, or permission of instructor.
For description, see INFO 447 in CIS section.

INFO 450(4500) Language and Technology (also COMM 450[4500]) (SBA)
Spring. 3 credits. Prerequisites: COMM 240 or 245 or permission of instructor.
For description, see COMM 450.

INFO 490(4900) Independent Reading and Research
Fall, spring. 1–4 credits.
Independent reading and research for undergraduates.

INFO 491(4910) Teaching in Information Science, Systems, and Technology
Fall, spring. Variable credit.
Involves working as a TA in a course in the information science, systems, and technology major.

INFO 515(5150) Culture, Law, and Politics of the Internet
Fall. 4 credits.
For description, see INFO 515 in CIS section.

INFO 530(5300) The Architecture of Large-Scale Information Systems (also CS 530[5300])
Spring. 4 credits. Prerequisite: CS/INFO 330 or CS 432.
For description, see INFO 530 in CIS section.

INFO 614(6140) Cognitive Psychology (also COGST 614, PSYCH 614[6140])
Fall. 4 credits.
For description, see PSYCH 614.

INFO 630(6300) Advanced Language Technologies (also CS 674[6740])
Fall or spring. In 2007–2008, offered in fall. 3 credits. Prerequisite: permission of instructor. Neither INFO/CS 430 nor CS 474 are prerequisites.
For description, see CS 674 in CIS section.

[INFO 634(6341) Information Technology in Sociocultural Context (also S&TS 634[6341])

INFO 635(6390) Seminar on Applications of Information Science (also INFO 435[4350])
Spring. 3 credits. Prerequisites: background in computing, data structures, and programming at level of CS/ENGRD 211 or equivalent, and experience in using information systems. Undergraduates and master's students should enroll in INFO 435; Ph.D. students should enroll in INFO 635.
For description, see INFO 635 in CIS section.

INFO 640(6400) Human–Computer Interaction Design (also COMM 640[6400])
Fall. 3 credits. Prerequisite: graduate standing or permission of instructor.
For description, see COMM 640.

[INFO 645(6450) Seminar in Computer-Mediated Communication (also COMM 645[6450])
Spring. 3 credits. Prerequisite: graduate standing or permission of instructor. Next offered 2009–2010.
For description, see COMM 645.]

INFO 648(6648) Speech Synthesis by Rule (also LING 648[6648])
Spring. 4 credits. Prerequisite: LING 401, 419, or permission of instructor.
For description, see LING 648.

INFO 650(6500) Language and Technology (also COMM 650[6500])
Spring. 3 credits. Prerequisite: graduate standing or permission of instructor.
For description, see COMM 650.

INFO 685(6850) The Structure of Information Networks (also CS 685[6850])
Fall. 4 credits. Prerequisite: CS 482.
For description, see INFO 685 in CIS section.

INFO 709(7090) IS Colloquium
Fall, spring. 1 credit. For staff, visitors, and graduate students interested in information science.

INFO 747(7400) Social and Economic Data (GR-RDC) (also ILRLE 740[7400])
Spring. 4 credits. Limited to Ph.D. and research master's students.
For description, see INFO 747 in CIS section.

INFO 790(7900) Independent Research
Fall, spring. Variable credit. Prerequisite: permission of an information science faculty member.
Independent research for M.Eng. students and pre–A exam Ph.D. students.

INFO 990(9900) Thesis Research
Fall, spring. Variable credit. Prerequisite: permission of an information science faculty member.
Thesis research for post–A exam Ph.D. students.

LANDSCAPE ARCHITECTURE

P. J. Trowbridge, chair (443 Kennedy Hall, 255-2738); M. I. Adleman, S. Baugher, K. L. Gleason, A. Hammer, P. H. Horrigan, D. W. Krall, L. J. Mirin, R. T. Trancik

LA 141(1410) Grounding in Landscape Architecture
Fall. 4 credits. Limited to 15 students. Letter grades only. Fee for required drafting equipment plus materials for projects: approx. $250.
Introduction to the representation and design of landscapes and to working in a studio setting. Uses freehand drawing, measured drawing, and model making to understand design principles of the changing landscape.

LA 142(1420) Grounding in Landscape Architecture
Spring. 4 credits. Limited to approx. 20 students. Prerequisite: freshman landscape architecture majors or permission of instructor. Required drafting equipment plus project supplies: approx. $250.
Applies fundamentals of landscape design to small-scale site-planning projects. Work in the studio introduces students to the design process, design principles, construction materials, planting design, and graphics.

LA 201(2010) Medium of the Landscape
Fall. 5 credits. Prerequisite: landscape architecture majors. Required drafting equipment, supplies, and fees: approx. $200; field trip: approx. $250.
Studio course emphasizing the design process and principles involved in organizing and giving form to outdoor space through the use of structures, vehicular and pedestrian circulation systems, earthforms, water, and vegetation.

LA 202(2020) Medium of the Landscape
Spring. 5 credits. Prerequisite: LA 201 with grade of C or better. Supplies and fees: approx. $250; field trip: approx. $250.
Focuses on the role of materials in design, design theory, and design vocabulary associated with landscape architecture projects.

LA 215(2150) Writing Seminar: Engaging Places
Fall. 4 credits. Lec. A. Hammer.
Explores how places come to be what they are, how they shape—and are shaped by—the people who live in them, how they become coordinates for plotting both a culture's biography and the meaning of a life. While the course serves as an introduction to cultural landscape studies, or the interaction of people and place, its focus is on writing: how do we represent the complexity of a place and our relation to it?

LA 252(2520) Daily Life and Cultural Landscapes (CA)
Fall. 3 credits. J. Zorn.
Surveys the common and not-so-common daily activities of the world of ancient Israel and its neighbors in Mesopotamia, Egypt, and Canaan. Many courses cover aspects of ancient political history or ancient literature, but these often focus on the activities of members of social elites, at the expense of the activities of more average citizens. The focus of this course on ancient technologies provides a broader spectrum, spanning all social classes. Material to be covered includes topics such as food production and processing, pottery production, metallurgy, glass making, cloth production and personal adornment, implements of war, medicine, leisure time (games and music), and others.

LA 261(2610) Fieldwork in Urban Archaeology (also CRP/ARKEO 261[2610]) (CA) (LA)
Fall. 4 credits. Three 8-hr. Sat. field labs required; students choose three Sat. from seven offered. S. Baugher.
Urban archaeologists study American Indian, colonial, and 19th-century sites that now lie within the boundaries of modern cities. This course explores how urban centers evolve; what lies beneath today's cities; and how various cultures have altered the urban landscape. Students participate in a local archaeological excavation.

LA 262(2620) Laboratory in Landscape Archaeology (also ARKEO 262[2620])
Spring. 3 credits. Recommended: LA 261 or ARKEO 261 or permission of instructor. S. Baugher.
Various American Indian civilizations and European cultures have altered the landscape to meet the needs of their cultures. Students learn how to interpret the American Indian and Euro-American landscapes of specific archaeological sites by identifying and dating artifacts, studying soil samples, and creating site maps.

[LA 263/547(2630/5470) American Indians, Planners, and Public Policy (also CRP 363/547[3630/5470]) (D) (CA) (LA)
Spring. 3 credits. Offered alternate years; next offered 2008–2009. S. Baugher.]

LA 266(2660) Jerusalem through the Ages (also NES 266[2660], JWST/ARKEO/RELST 266[2660]) (CA) (LA)
Fall. 3 credits. J. Zorn.
Explores the history, archaeology, and natural topography of Jerusalem throughout its long life, from its earliest remains in the Chalcolithic period (ca. 4000 B.C.E.) to the 19th century, including Jebusite Jerusalem, Jerusalem as the capital of the Davidic dynasty, the Roman era city of Herod and Jesus, the Crusaders and medieval Jerusalem, and Ottoman Jerusalem as the city entered the modern era. Students examine the original historical sources (e.g., Bible, Josephus, and the Madeba map) that pertain to Jerusalem. Uses slides and videos to illustrate the natural features, human-built monuments, and artifacts that flesh out the textual material, providing a fuller image of the world's most prominent spiritual and secular capital.

LA 282(2820) Photography and the American Landscape (CA) (LA)
Fall. 3 credits. A. Hammer.
Interdisciplinary study of the relationship between photography, the American landscape, and cultural meaning. Topics include representation and perception, photography and painting in the 19th century, expeditionary surveys and national identity, pictorialism, the American sublime, photography and tourism, modernism and postmodernism, the industrial landscape and American ruins, and contemporary practice.

LA 301(3010) Integrating Theory and Practice I
Fall. 5 credits. Prerequisite: LA 202 with grade of C or better. Supplies and fees: approx. $250; field trip: approx. $250.
Engages participants in the art and science of design. The studio focuses on site-scaled projects that consider significant cultural and natural landscapes. Explores theories of landscape restoration, sustainable design, and landscape representation through projects that derive form from a specific site and place.

LA 315(3150) Site Engineering I
Spring. 3 credits. Prerequisite: permission of instructor. M. Adleman.
Lectures and studio projects focusing on the professional skills and knowledge required to competently and creatively develop grading plans for project-scale site design.

LA 316(3160) Site Engineering II
Fall. 2 credits. Prerequisite: LA 315 or permission of instructor. M. Adleman.
Lectures and studio projects dealing with earthwork estimating; storm water management, site surveys, site layout, and horizontal and vertical road alignment.

LA 318(3180) Site Construction
Spring. 5 credits. Prerequisite: permission of instructor. P. Trowbridge.
Emphasizes detail design and use of landscape materials in project implementation. Explores construction materials, including specifications, cost estimates, and methods used by landscape architects in project implementation. Includes lectures, studio problems, and development of drawings leading to construction documentation for one or more comprehensive projects.

LA 360(3600) Pre-Industrial Cities and Towns of North America (also ARKEO 360[3600], CRP 360/666[3600/6660], LA 666[6660]) (CA) (LA)
Spring. 3 credits. S. Bausher.

LA 401(4010) Urban Design Studio
Fall. 5 credits.
Site design and construction projects introduced as an evaluation of each student's professional competency in landscape architecture.

LA 402(4020) Integrating Theory and Practice II
Spring. 5 credits. Supplies and fees: approx. $250; field trip: approx. $250.
Studio focusing on the expression of design solutions that grow from and affirm an explicit sense of site and place. Social, cultural, physical, and historic factors and their relationships to site design and planning are critically explored through theory and practice in this studio.

LA 403(4030) Directed Study: The Concentration
Fall, spring. 1 credit. Prerequisite: landscape architecture undergraduates in final year of study.
Working with their advisor, students create a written and visual paper that documents the concentration intent.

LA 410(4100) Computer Applications in Landscape Architecture (D)
Fall or spring. 3 credits. Limited to 15 students. Prerequisite: landscape architecture students. S. Curtis.
Designed to develop a working knowledge of various computer software applications with emphasis on Autocad. Explores other applications relative to land-use planning and the profession of landscape architecture.

LA 412(4120) Professional Practice
Spring. 1 credit.
Presents the student with an understanding of the role of the professional landscape architect. The course helps students choose a type of practice and introduces the problems and opportunities one may encounter in an office or in other professional situations. Topics include job-seeking preparation, practice diversity, marketing professional services, office and project management, construction management, computers in the profession, and ethics.

LA 418(4180) Audio Documentary: Stories from the Land (CA) (LA)
Spring. 3 credits. Limited to 15 students. Letter grades only. A. Hammer.
Offers hands-on experience in basic audio documentary. Students create aural portraits of New York landscapes and communities undergoing critical change. Encourages projects appropriate for podcasting, webcasting and radio. Explores relationship between sound and the still or moving image.

LA 483(4830) Seminar in Landscape Studies (CA) (LA)
Spring. 3 credits. Prerequisite: senior or graduate standing in any major or field.
Topical seminar with a different subject and method each time it is offered.

LA 486(4860) Placemaking by Design
Fall. 3 credits. Limited to 20 students. Priority given to juniors, seniors, and graduate students. S-U or letter grades. P. Horrigan.
Seminar providing an understanding of contemporary planning and landscape architecture design strategies that reaffirm and reclaim a sense of place. Readings and discussions focus on the theory and practice of placemaking as represented in the literature and in built works. Addresses the following questions: What constitutes a place-based design approach and what distinguishes it from other more conventional design approaches? Who are the key players shaping the theory and practice of placemaking?

LA 491(4910) Creating the Urban Eden: Woody Plant Selection, Design, and Landscape Establishment (also HORT 491[4910])
Fall. 4 credits. Limited to 48 students. Prerequisite: horticulture or landscape architecture majors or permission of instructors. Preregistration required. Supplies: approx. $50; field trips: approx. $25. P. Trowbridge and N. Bassak.
Focuses on the identification, uses, and establishment of woody plants in urban and garden settings. By understanding the environmental limitations to plant growth, students are able to critically assess potential planting sites; select appropriate trees, shrubs, vines, and ground covers for a given site; and learn about the principles and practices of site amelioration and plant establishment. Design followed by written specifications and graphic details is produced to implement these practices.

LA 492(4920) Creating the Urban Eden: Woody Plant Selection, Design, and Landscape Establishment (also HORT 492[4920])
Spring. 4 credits. Limited to 48 students. Prerequisite: horticulture or landscape architecture majors or permission of instructors; passing grade in HORT/LA 491. Preregistration required. Supplies: approx. $50; field trips: approx. $25. P. Trowbridge and N. Bassuk.
Second half of course focusing on winter identification, uses, and establishment of woody plants in urban and garden settings. Issues of site assessment and soil remediation are emphasized in addition to soil volume calculations, drainage and surface detailing, and planting techniques. Students critically assess potential planting sites; and select appropriate trees, shrubs, vines and ground covers for a given site. Designs for specific sites are followed by written specifications, and graphic details are produced to implement these proposals. Students are engaged in a hands-on manner in site remediation and planting techniques they have learned by creating new landscapes that serve to integrate theory, principles, and practices. Together, HORT/LA 491 and 492 constitute an integrated course.

LA 494(4940) Special Topics in Landscape Architecture
Fall or spring. 1–3 credits; may be repeated for credit. S-U or letter grades.
Topical subjects in landscape architectural design, theory, history, or technology. Group study of topics not considered in other courses.

LA 495(4950) Green Cities: The Future of Urban Ecology (also CRP 384/584[3840/5840])
Fall. 4 credits. R. Young.
Explores the history and future of the ecology of cities and their role in solving the present global ecological crisis. Examines the politics, design, and economics of "green cities" in terms of transportation, renewable energy, solid waste and recycling, land use, and the built environment.

LA 497(4970) Individual Study in Landscape Architecture
Fall or spring. 1–5 credits; may be repeated for credit. Students must register using independent study form (available in 140 Roberts Hall). S-U or letter grades.
Work on special topics by individuals or small groups.

LA 498(4980) Undergraduate Teaching
Fall or spring. 1–2 credits. Prerequisites: previous enrollment in course to be taught and permission of instructor. Students must register using independent study form (available in 140 Roberts Hall).
Designed to give qualified undergraduates experience through actual involvement in planning and teaching courses under the supervision of department faculty members.

LA 499(4990) Undergraduate Research
Fall or spring. 1–5 credits. Students must register using independent study form (available in 140 Roberts Hall).
Permits outstanding undergraduates to carry out independent research in landscape architecture under appropriate faculty supervision. Research goals should include description, prediction, and explanation, and should generate new knowledge in the field of landscape architecture.

LA 501(5010) Composition and Theory
Fall. 5 credits. Prerequisite: graduate standing. Drafting supplies and fees: approx. $250; field trip: approx. $250.
Basic principles of natural and cultural processes that form "places" in the landscape. Projects focus on design applied to the practice of landscape architecture: particularly the relationship between measurement, process, experience, and form at multiple scales of intervention.

LA 502(5020) Composition and Theory
Spring. 5 credits. Prerequisite: graduate standing. Drafting supplies and fees: approx. $250; field trip: approx. $250.
Studio focusing on the spatial design of project-scale site development. Students develop their expertise in applying the design theory, vocabulary, and graphic expression introduced in LA 501.

LA 505(5050) Landscape Representation I
Fall. 3 credits. Corequisite: LA 501 or permission of instructor.
Introduces students to both conventional and unconventional modes of landscape architectural design representation. Teaches drafting, orthographic drawing, axonometric project, lettering, analysis, and concept drawing alongside more expressive modes of direct site study and representation.

LA 506(5060) Graphic Communication II
Spring. 3 credits. Prerequisite: LA 505. Corequisite: LA 502 or permission of instructor.
Intermediate-level course focusing on modes of landscape representation from ideation to presentation. Representation modes may include freehand, process drawing, analysis and orthographic drawing; concept modeling; composite drawings; and visual books.

LA 524(5240) History of European Landscape Architecture*
Fall. 3 credits. L. Mirin.
*Offered through College of Architecture, Art, and Planning.

LA 525(5250) History of American Landscape Architecture*
Spring. 3 credits. L. Mirin.
*Offered through College of Architecture, Art, and Planning.

LA 545(5450) The Parks and Fora of Imperial Rome
Spring. 3 credits. Prerequisites: advanced standing in a design field, classics, or history of art, other disciplines, or permission of instructor. K. Gleason.
Advanced seminar seeking an interdisciplinary group of students in classics, art history, archaeology, landscape architecture, horticulture, and architecture to bring their knowledge of Latin, Greek, Italian, archaeology, drawing, design, or computer modeling to a collaborative study of the ancient forums and public parks depicted on the Severan Marble plan of Rome. Opportunity for a spring break trip to Rome.

[LA 569(5690) Archaeology in Preservation Planning and Site Design (also CRP 569[5690])
Spring. 3 credits. Offered alternate years; next offered 2008–2009. S. Baugher.]

LA 580(5800) Landscape Preservation: Theory and Practice
Fall. 3 credits. Prerequisite: junior, senior, or graduate standing. D. Krall.
Examines the evolving practice of landscape preservation in the United States. Topics include the recent history of the discipline, methodology in documentation of historic landscapes, and important practitioners and notable projects. Format is assigned readings and discussion, invited speakers, lectures, and a project documenting a local site.

LA 582(5820) Photography and the American Landscape
Fall. 3 credits. A. Hammer.
Interdisciplinary study of the relationship between photography, the American landscape, and cultural meaning. Topics include representation and perception, photography and painting in the 19th century, expeditionary surveys and national identity, pictorialism, the American sublime, photography and tourism, modernism and postmodernism, the industrial landscape and American ruins, and contemporary practice.

LA 590(5900) Theory Seminar
Fall. 3 credits. Prerequisite: senior or graduate standing. A. Hammer.
This seminar is organized around foundational texts and theoretical debate germane to landscape architecture. Topics may include, but not be limited to, environmental perception, issues of language and representation, pertinent debate in cultural geography, developments in ecological design, landscape urbanism, infrastructure, etc. Weekly readings, discussion, short papers.

LA 598(5980) Graduate Teaching
Fall or spring. 1–3 credits. Prerequisite: permission of instructor. Students must register using independent study form (available in 140 Roberts Hall). Staff.
Designed to give qualified students experience through involvement in planning and teaching courses under the supervision of faculty members. The experience may include leading discussion sections, preparing, assisting in desk critiques, and presenting lectures. There are assigned readings and discussion sessions on education theory and practice throughout the semester. (Credit hours are determined by the formula: 2 hours per week = 1 credit hour).

LA 601(6010) Integrating Theory and Practice I
Fall. 5 credits. Prerequisite: graduate standing or permission of instructor. Supplies and fees: approx. $250.
Studio focusing on site-scaled projects that consider significant cultural and natural landscapes. Explores theories of landscape restoration, sustainable design, and landscape representation are explored through projects that derive form from specific site and place. The integration of site history, ecology, and site construction supports an understanding and relationship between design and site. This course will also engage sound and landscape, requiring students to also register for the 1-credit seminar LA 605.

LA 602(6020) Integrating Theory and Practice II
Spring. 5 credits. Prerequisite: graduate standing. Drafting supplies and fees: approx. $250; field trip: approx. $250.
Studio building on prior course work with an expectation that participants can creatively manipulate the program and conditions of a site, with increased emphasis on contemporary construction technology. Focuses on the expression of design solutions that grow from and affirm an explicit sense of site and place. Social, cultural, physical, and historic factors and their relationship to site design and planning are critically explored through theory and practice.

LA 603(6030) Directed Study: The Concentration
Fall, spring. 1 credit. Prerequisite: landscape architecture graduate students in final year of study.
Working with their advisor, students create a written and visual paper that documents the concentration intent.

LA 615(6150) Site Engineering I
Spring. 3 credits. Prerequisite: permission of instructor. M. Adleman.
Lectures and studio projects focusing on the professional skills and knowledge required to competently and creatively develop grading plans for project-scale site design.

LA 616(6160) Site Engineering II
Fall. 2 credits. Prerequisite: LA 615 or permission of instructor. M. Adleman.
Lectures and studio projects dealing with earthwork estimating, storm water management, site surveys, site layout, and horizontal and vertical road alignment.

LA 618(6180) Site Construction
Spring. 5 credits. Prerequisite: permission of instructor. P. Trowbridge.
Emphasizes detail design and use of landscape materials in project implementation. Explores materials, including specifications, cost estimates, and methods used by landscape architects in project implementation. Includes lectures, short studio problems, and the development of drawings leading to construction documentation for one or more comprehensive projects.

LA 666(6660) Pre-Industrial Cities and Towns of North America (also CRP 666[6660]) (D)
Spring. 3 credits.

LA 680(6800) Graduate Seminar in Landscape Architecture
Fall or spring. 1–3 credits; may be repeated for credit. Prerequisite: graduate standing. S-U or letter grades.
Topical subjects in landscape architectural design, theory, history, or technology. Includes seminar topics and group study not considered in other courses.

LA 694(6940) Special Topics in Landscape Architecture
Fall or spring. 1–3 credits; may be repeated for credit. S-U or letter grades.
Topical subjects in landscape architectural design, theory, history, or technology. Includes group study of topics not considered in other courses.

LA 701(7010) Urban Design and Planning: Designing Cities in the Electronic Age (also CRP 555[5550])
Fall. 5 credits. Prerequisite: graduate standing. Supplies and fees: approx. $250; required field trip: approx. $250.
Application of urban-design and town-planning techniques to specific contemporary problems of city environments. Investigates issues of urbanism and applies them to physical design interventions and spatial typologies involving the street, square, block, garden, and park systems. Introduces three-dimensional computer modeling and digital design media as tools for urban design. This is a specially arranged collaborative studio with the Department of City and Regional Planning.

LA 702(7020) Advanced Design Studio
Spring. 5 credits.
Capstone studio providing the opportunity to explore issues in contemporary landscape architecture and to integrate related fields. Topics include the influences of culture, history, and criticism, as well as reinterpretations of engineering and representation.

LA 800(8000) Master's Thesis in Landscape Architecture
Fall or spring. 9 credits.
Independent research, under faculty guidance leading to the development of a comprehensive and defensible design or study related to the field of landscape architecture. Work is expected to be completed in final semester of residency.

NATURAL RESOURCES

M. E. Krasny, chair (118 Fernow Hall, 255-2822); M. B. Bain, B. L. Bedford, B. Blossey, T. Brown, L. E. Buck, E. Cooch, P. Curtis, D. J. Decker, J. Dickinson, J. Enck, T. J. Fahey, T. A. Gavin, G. Goff, M. Hare, J. R. Jackson, B. A. Knuth, C. Kraft, M. E. Krasny, J. P. Lassoie, B. Lauber, R. A. Malecki, E. Mills, S. Morreale, M. E. Richmond, L. Rudstam, R. Schneider, R. Sherman, P. J. Smallidge, C. R. Smith, R. Stedman, K. Sullivan, P. Sullivan, J. Tantillo, N. Trautmann, S. Wolf, J. B. Yavitt

NTRES 100(1001) Introduction to Environmental Studies
Summer. 3 credits. S-U or letter grades. R. J. McNeil.
Discussion-centered course examining the interrelationships between the sciences, arts, and humanities as they relate to our environment. Students explore how we manage nature and negotiate with each other to meet our needs. Emphasis is on principles of ecology, economics, aesthetics, ethics, and law.

NTRES 101(1010) Intro to the Science and Management of Environmental and Natural Resources (also SNES 101[1010])
Fall. 3 credits. Prerequisite: first-year students in Natural Resources, Science of Natural and Environment Systems, or other "environmental cluster" areas in CALS. J. Lassoie and E. Madsen.
This course provides an overview of the science and management of natural and environmental resources. Material highlights facts and principles from the physical, biological, social, and economic sciences. The focus is on identifying knowledge required to enhance intelligent and sustainable management of the Earth's ecological and environmental systems. Case studies, guided readings, multi-media presentations, discussions, and field and laboratory exercises are used to introduce students to the interdisciplinary basis for understanding the complexities of such systems within the text of modern society. Active student participation in all phases of the course is expected.

NTRES 102(1020) Science Fiction and Environment
Summer. 3 credits. S-U or letter grades. R. J. McNeil.
This course is intended to be primarily for Summer College students (high school rising seniors), new freshmen, Cornell staff, and other people with an interest in, but little formal background in environmental studies. Science fiction short stories and two books will be used as vehicles for illustrating environmental predicaments and to enable easy discussion of environmental principles which may be helpful to us in choosing ways to live. Some extra attention to studying and learning may be helpful to new college students.

NTRES 201(2010) Environmental Conservation
Spring. 3 credits. T. Fahey.
Our lives increasingly are touched by questions about environmental degradation at local, regional, and global scales. Business as usual is being challenged. This course stimulates students to go beyond the often simplistic portraits of the environmental dilemma offered by the mass media to gain a firmer basis for responsible citizenship and action on environmental issues.

NTRES 210(2100) Introductory Field Biology
Fall. 4 credits. Limited to 60 students. Prerequisite: sophomore or junior standing with advisor in natural resources or permission of instructor; BIO G 101 and 102 or equivalent. Cost of two required overnight weekend field trips: approx. $12. T. Gavin and C. Smith.
Introduction to methods of inventorying, identifying, and studying plants and animals. Students are required to learn taxonomy, natural history, and how to identify approximately 170 species of vertebrates and 80 species of woody plants. Stresses selected aspects of current ecological thinking. Emphasizes the interaction of students with biological events in the field and accurate recording of those events.

NTRES 232(2320) Nature and Culture (HA) (CA)
Spring. 3 credits. S-U or letter grades. J. Tantillo.
We will examine the history of human-environment relationships, the diversity of environmental values and ethics, cultural manifestations of nature, and the role of society in forming natural resource and environmental policy. The history of natural resource conservation and management in North America, including the history and philosophy of ecology, will be introduced.

NTRES 303(3030) Introduction to Biogeochemistry (also EAS 303[3030])
Fall. 4 credits. Prerequisites: college-level chemistry and a biology and/or geology course. J. B. Yavitt and L. A. Derry.
For description, see EAS 303.

NTRES 310(3100) Applied Population Ecology
Fall. 3 credits. Prerequisite: completion of calculus (MATH 106, 111, or equivalent). Highly recommended: background in biology or ecology. Letter grades only. E. Cooch.
In-depth analysis of the ecological factors influencing the natural fluctuation and regulation of animal population numbers. Examines models of single- and multi-species population dynamics, with emphasis on understanding the relationship between ecological processes operating at the individual level and subsequent dynamics at the population level. Significant emphasis is placed on principles as applied to conservation and management. Computer exercises are used to reinforce concepts presented in lecture.

NTRES 311(3110) Fish Ecology, Conservation, and Management
Spring. 3 credits. Prerequisites: none. Recommended: NTRES 210, BIOEE 261, or equivalent. E. Mills, L. Rudstam, and R. Jackson.
Covers basic principles of fish ecology at the individual, population, and community level, particularly as they relate to interactions between fish and their environment and the implications of human activities to these relationships. Emphasizes the application of ecological principles to the conservation and management of fisheries resources and aquatic habitats. Extensive use of current literature and case studies will provide context for principles covered.

NTRES 312(3111) Fish Ecology Laboratory
Spring, four field trips TBA. 1 credit. Pre- or corequisite: NTRES 311. E. Mills, L. Rudstam, and R. Jackson.
Four field trips are planned to provide hands-on experiences in fish ecology and management. They include: a one-weekday Great Lakes experience aboard the USGS Kahoe on Lake Ontario, a one-day Oneida Lake trip to a state-of-the-art fish hatchery during the walleye run, a one-day Oneida Lake weekend trip to the Cornell Biological Field Station experiencing fish collection techniques, and a two-hour trip to Cayuga Inlet to witness the spring run of rainbow trout and possibly lamprey eels. Activities include demonstrations of various fish sampling gears and sample analysis techniques. Each student is required to maintain a written journal describing activities and concepts learned from each field trip that will be turned in at the end of the semester.

NTRES 313(3130) Biological Statistics I (also BTRY 301[3010])
Fall. 4 credits. Prerequisite: one semester of calculus. P. Sullivan.
Develops statistical methods and applies them to problems encountered in the biological and environmental sciences. Methods include data visualization, population parameter estimation, sampling, bootstrap resampling, hypothesis testing, the Normal and other probability distributions, and an introduction to modeling. Applied analysis is carried out in the Splus statistical computing environment.

NTRES 314(3140) Conservation of Birds
Summer. 2 credits. Prerequisite: NTRES 210 or permission of instructor. C. R. Smith.
A course for majors and non-majors, focusing on science-based bird conservation and management at the organism, population, community, and landscape levels. Current resource management issues relevant to birds are explored in the contexts of agricultural practices, habitat management, tropical deforestation, the design and management of natural preserves, endangered species management, global climate change, and the economic importance of bird study as an outdoor recreational activity.

NTRES 315(3141) Conservation of Birds Laboratory
Summer. 1 credit. Corequisite: NTRES 314. C. R. Smith.
A field-oriented course designed to teach skills of bird observation and identification based on the integration of field marks, songs and calls, and habitat cues. Topics covered include the choice and effective use of field guides, binoculars, and other tools for bird identification; procedures for taking and organizing field notes; the relationships of birds to their habitats and to other birds; and methods and procedures for censusing and surveying the songbird population.

NTRES 322(3220) Global Ecology and Management
Spring. 3 credits. Prerequisites: college-level biology and general ecology course. J. B. Yavitt.
The subjects of biogeography, ecology, and biodiversity have patterns and processes that emerge only at the global scale. Recognizing the global importance of these patterns and processes is even more imperative in light of the tremendous increase in the human population size and the effects of humans on the Earth. This course is an introduction to the field of global ecology. Topics include comparative ecology and biogeography, community ecology, island biogeography, and ramifications of global climatic change.

NTRES 324(3240) Ecological Management of Water Resources
Spring. 3 credits. Prerequisites: introductory ecology and introductory chemistry or permission of instructor. R. Schneider.
In-depth analysis of those ecological and biological principles relevant to the management of fresh and marine water resources, with emphasis on the effects of water management on community ecology. Lectures and discussion integrate scientific literature with current management issues. Topics include linkages between hydrologic variability and communities; groundwater-surface connections, flow paths for dispersal, patchily distributed water resources, and water quality controls on organisms.

NTRES 325(3250) Forest Management and Maple Syrup Production
Spring. 3 credits. Letter grades only. Offered alternate even-numbered years. P. J. Smallidge.
Practical, field-oriented course emphasizing principles and practices of stewardship and multiple purpose management of small, nonindustrial, private forest land in the northeastern United States, including the production of maple syrup.

NTRES 326(3260) Applied Conservation Ecology
Spring. 3 credits. Prerequisite: BIOEE 261 or permission of instructor. S. Morreale.
Field and lab course designed to provide direct experience with some of the most important field methods and analytical techniques used to examine ecosystem and community function, structure, and value, especially within the context of contemporary conservation ecology and evolutionary theory. Tools include field sampling techniques, resource and conservation mapping, spatial referencing, GIS, measures of biodiversity, and manual and automated techniques for studying soil, stream, and forest biota and related physical factors.

NTRES 330(3300) Natural Resources Planning and Management
Fall. 3 credits. Prerequisite: junior standing. T. B. Lauber.
Focuses on terrestrial and aquatic resources. Emphasizes the comprehensive planning process and human dimensions of resource management. Students integrate biological, social, and institutional dimensions of management through case studies. Grades are based on individual and group performance.

NTRES 331(3310) Environmental Governance (also S&TS/B&SOC/D SOC 331[3311]) (SBA)
Spring. 3 credits. S. Wolf.
Considers the question of environmental governance, defined as the assemblage of social institutions that regulate natural resource use and shape environmental outcomes. Participants explore the roles of public policy, market exchange, and collective action in resource (mis)management. Introduces theoretical concepts from a variety of social science perspectives to support case studies and student-led discussions. Comparative analysis of how governance is pursued in different countries, historical periods, and ecological contexts (forestry, endangered species, water quality) highlight scope for institutional innovation. Course details at www.dnr.cornell.edu/saw44/ntres331.html.

NTRES 332(3320) Introduction to Ethics and Environment (KCM)
Fall. 4 credits. J. Tantillo.
Introduction to ethics, aesthetics, and epistemology as related to the environment. Asks the question "How should I live?" and explores the implications of different answers to that question for our treatment of nature. Also examines the various approaches to ethics theory; the relations between art, literature, religion, and mortality; the

objective nature of value judgments; and the subjective nature of nature.

NTRES 410(4100) Conservation Biology: Concepts and Techniques
Fall. 4 credits. Limited to 30 students. Prerequisite: juniors, seniors, or graduate students; NTRES 310 or equivalent. Recommended: NTRES 210. E. G. Cooch and T. A. Gavin.
Thorough analysis the ecological and quantitative dimensions for decision making in modern conservation biology and management. Emphasizes analysis of variation and maintenance of biological diversity, and focuses on principles and techniques, including demographic viability analysis of populations, genetic analysis, as well as aspects of the human dimensions of conservation biology.

[NTRES 411(4110) Quantitative Ecology and Management of Fisheries Resources
Spring. 4 credits. Prerequisites: NTRES 313 recommended or permission of instructor. S-U or letter grades. Offered alternate years; next offered 2008–2009. P. J. Sullivan.
Examines the dynamics of marine and freshwater fisheries resources with a view toward observation, analysis, and decision making within a quantitative framework. Growing pressure on fisheries' resources, habitat modification, and increased uncertainty about the nature of biological systems are at the center of many fisheries' issues. Quantitative models are useful for integrating information needed by decision makers in addressing these issues. The course develops analytical methods to assess the dynamics and status of fisheries' resources and then demonstrates how the information may be transformed into useful information for decision makers.]

NTRES 412(4120) Wildlife Population Analysis: Techniques and Models
Spring. 3 credits; two-week intensive course (M T W R F a.m. lec, p.m. labs) in Jan. with follow-up meetings during spring semester. Prerequisites: NTRES 310 (or equivalent or permission of instructor), college-level math or statistics course. Lec/lab. E. Cooch.
This course will explore the theory and application of a variety of statistical estimation and modeling techniques used in the study of wildlife population dynamics. The course will focus on exploration of a selection of the tools needed for modern wildlife conservation and management, including (particularly) analysis of mark–recapture data, population viability analysis, community analysis, decision theory, and matrix modeling.

NTRES 413(4130) Biological Statistics II (also BTRY 302[3020])
Spring. 4 credits. Prerequisite: NTRES 313 or BTRY 301. Staff.
Applies linear statistical methods to quantitative problems addressed in biological and environmental research. Methods include linear regression, inference, model assumption evaluation, the likelihood approach, matrix formulation, generalized linear models, single factor and multifactor analysis of variance (ANOVA), and a brief foray into nonlinear modeling. Applied analysis is carried out in the Splus statistical computing environment.

NTRES 420(4200) Forest Ecology
Fall. 3 credits. Prerequisite: introductory biology. T. J. Fahey.
Comprehensive analysis of the distribution, structure, and dynamics of forest ecosystems. Topics include paleoecology of forests; ecophysiology of forest trees; disturbance, succession and community analysis; primary productivity; and nutrient cycling.

NTRES 421(4201) Forest Ecology Laboratory
Fall. 1 credit. Corequisite: NTRES 420. Weekend trip: approx. $30. T. J. Fahey.
Field trips designed to familiarize students with the nature of regional forests and to provide experience with approaches to quantifying forest composition and its relation to environmental factors. Optional weekend field trips to Adirondacks and to the White Mountains, New Hampshire. Includes group research projects in local forests.

NTRES 422(4220) Wetland Ecology and Management—Lecture
Fall. 3 credits. Prerequisite: BIOEE 261. B. L. Bedford.
Examination of the structure, function, and dynamics of wetland ecosystems with an emphasis on ecological principles required to understand how human activities affect wetlands. Topics include geomorphology, hydrology, biogeochemistry, plant and animal adaptations to wetland environments, and vegetation dynamics of freshwater and saline wetlands. Considers current regulations, protection programs, and management strategies.

NTRES 423(4221) Wetland Ecology and Management—Laboratory
Fall. 1 credit. Optional. Corequisite: NTRES 422. One weekend field trip required. B. L. Bedford.
Integrated set of field and laboratory exercises designed to expose students to the diversity of wetland ecosystems; the vegetation, soils, water chemistry, and hydrology of wetlands in the region; methods of sampling wetlands vegetation, soils, and water; and methods of wetland identification and delineation.

[NTRES 424(4240) Landscape Impact Analysis
Spring. 3 credits. Prerequisites: junior standing; one introductory and one advanced course in ecology or equivalents. Offered alternate years; next offered 2008–2009. B. L. Bedford.
Presents ecological concepts and analytical tools needed to evaluate environmental impacts to natural resources and ecosystems within an integrated context that incorporates the landscapes in which these resources occur. Explores diverse conceptual frameworks for landscape impact analysis and exposes students to modern tools for evaluating landscapes.]

[NTRES 426(4260) Practicum in Forest Farming as an Agroforestry System (also HORT/CSS 426[4260])
Fall. 2 credits. Offered alternate years; next offered 2008–2009. K. W. Mudge, L. E. Buck, and P. Hobbs.
Students actively take part in the development and management of a 70-year-old nut grove originally planted at Cornell in the 1930s. The MacDaniel's Nut Grove is being developed as a multipurpose forest-farming teaching, research, and extension site. Hands-on activities include all or most of the following: temperate-nut harvest and variety evaluation, mushroom culture, small-fruit and fruit-tree culture, medicinal-herb culture, site evaluation and planning, and field trips to other agroforestry-related sites. Outdoor activities are integrated with selected readings via an online discussion board.]

NTRES 428(4280) Principles and Practices of Applied Wildlife Science
Spring. 3 credits. Prerequisites: NTRES 310 or equivalent; permission of instructor. S-U or letter grades. Offered alternate even-numbered years. M. E. Richmond, R. A. Malecki, and P. D. Curtis.
The course covers the theory and practice of solving wildlife-related resource issues. Differences between basic and applied wildlife science will be discussed. The application of basic science and the scientific method will be integrated into community/agency-based problem solving. Issues and approaches to management of terrestrial and wetland wildlife will be discussed with emphasis on technical, logistical, analytical, and communication skills.

NTRES 430(4300) Environmental and Natural Resources Policy Processes
Spring. 3 credits. Prerequisites: junior standing; special application process. Lec, Wash., D.C., during Jan. 11-day winter session; three two-hour orientation sessions in fall semester and four two-hour sessions in Feb. and March. Fee: approx. $450. Completed applications due by Oct 11. Applications available by contacting map10@cornell.edu or at www.dnr.cornell.edu/teaching/ugrad/courses/. B. A. Knuth.
Intensive field-based exploration of the environmental policy process and its conceptual framework. Defining environmental problems; aggregating interests; agenda-setting; formulating and selecting alternative solutions; implementation and evaluation stages; roles of lobbyists, legislature, executive branch, and other actors. Case studies; discussion with about 20 prominent Washington policymakers who appear as guest panelists. Self-selected research topic requires conducting independent interviews with Washington experts, policy analysis paper, and oral presentation.

NTRES 431(4310) Environmental Strategies (also D SOC 432[4320]) (SBA)
Spring. 3 credits. S. Wolf.
Research-oriented seminar focused on conservation of natural resources in the contemporary political and institutional environment. We study opportunities to mobilize market mechanisms and competitive strategies of firms to harmonize economic and environmental demands on ecological systems. Through production of a portfolio of analyses of real-world integrated environmental management schemes, students will come to understand the mechanics of this general class of environmental policy tools and develop a critique as to why the market does not represent a comprehensive approach to sustainability. Course details at www.dnr.cornell.edu/saw44/ntres431.html.

NTRES 432(4320) Human Dimensions of Natural Resource Management
Spring. 3 credits. Prerequisite: junior or senior standing. S-U or letter grades. Staff.
Focuses on how a social science–based understanding of human attitudes, values, and behaviors can be incorporated in natural resource management decisions and actions. Uses examples from federal, state, and nongovernmental fish, wildlife, and forest management programs to illustrate the importance of socioeconomic considerations in problem solving and decision making.

[NTRES 433(4330) Applied Environmental Philosophy (KCM)
Spring. 3 credits. Recommended: NTRES 332. Next offered 2008–2009. J. Tantillo.
Focuses on environmental philosophy and environmental ethics considered as an academic field. Major themes include anthropocentrism versus non-anthropocentrism, intrinsic value, monism versus pluralism, animal rights versus environmental ethics, and various approaches to environmental ethics, including deep ecology, ecofeminism, and pragmatism.]

NTRES 434(4340) International Conservation: Communities and the Management of the World's Natural Resources
Fall. 3 credits. Letter grades only. J. Lassoie.
Lectures, readings, and multimedia information, including the Internet, build a multidisciplinary understanding of the principles underpinning conservation and natural-resource management. Specific attention is given to the role of local communities in developing sustainable land-use strategies. Case studies from Africa, Latin America, Asia, and the United States examine particular conservation and management issues from widely different geopolitical perspectives. Stakeholder analyses are used to base discussions of each case, followed by a synthesis and discussion of key contrasts and comparisons centered on common themes identified during the course.

NTRES 444(4440) Resource Management and Environmental Law (also CRP 444[4440])
Spring. 3 credits. Prerequisite: junior, senior, or graduate standing. S-U or letter grades. R. Booth.
For description, see CRP 444.

NTRES 456(4560) Stream Ecology (also BIOEE 456[4560])
Fall. 4 credits. Limited to 40 students. Prerequisite: BIOEE 261 or permission of instructor. S-U or letter grades. One Sat field trip. Offered alternate odd-numbered years. C. Kraft and A. Flecker.
Lecture examines patterns and processes in stream ecosystems, including geomorphology and hydrology, watershed–stream interactions, trophic dynamics, biogeochemistry, disturbance, and conservation and management. Field and laboratory exercises focus on experimental and analytical techniques used to study stream ecosystems, including techniques to measure stream discharge, physical habitat, water chemistry, and stream biota. Field project with lab papers.

NTRES 480(4800) Global Seminar: Building Sustainable Environments and Secure Food Systems for a Modern World (also FD SC/IARD 480[4800])
Spring. 3 credits. Prerequisite: junior, senior, or graduate standing. J. Lassoie and D. Miller.
Modernization has led to development pressures that have increasingly disrupted natural systems leading to widespread concerns about the long-term viability of important environmental services, including those critical to food security worldwide. This multidisciplinary course uses case studies to explore interrelationships among social, economic, and environmental factors basic to sustainable development. Cases examine contemporary issues such as population growth, genetically modified foods, biodiversity, sustainable marine fisheries, tourism, global warming, and global responsibility. Cornell faculty members lead discussions in each of the major topic areas. In addition, students participate in discussions and debates with students from Sweden, Costa Rica, Honduras, South Africa, and Australia through live interactive videoconferences and electronic discussion boards.

NTRES 493(4930) Individual Study in Resource Policy, Management, and Human Dimensions
Fall, spring, or winter. Credit TBA. Prerequisite: permission of instructor. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall). R. A. Baer, T. Brown, L. E. Buck, D. J. Decker, J. Enck, J. Gillett, B. Knuth, T. B. Lauber, R. Stedman, J. Tantillo, and S. Wolf.
Topics in environmental and natural resource policy, management, and human dimensions are arranged depending on the interests of students and availability of staff.

NTRES 494(4940) Special Topics in Natural Resources
Fall or spring. 4 credits max. S-U or letter grades.
The department teaches "trial" courses under this number. Offerings vary by semester, and are advertised by the department before the semester starts. Courses offered under the number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

NTRES 495(4850) Individual Study in Fish and Wildlife Biology and Management
Fall or spring. Credit TBA. Prerequisite: permission of instructor. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall). M. Bain, E. Cooch, P. Curtis, T. Gavin, M. Hare, J. R. Jackson, C. Kraft, R. Malecki, E. Mills, S. Morreale, M. Richmond, L. Rudstam, C. Smith, and P. Sullivan.
Topics in fish and wildlife biology and management are arranged depending on the interests of students and availability of staff.

NTRES 496(4960) Individual Study in Ecology and Management of Landscapes
Fall or spring. Credit TBA. Prerequisite: permission of instructor. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall). B. Bedford, B. Blossey, T. Fahey, M. Krasny, J. Lassoie, R. Schneider, R. Sherman, P. Smallidge, and J. Yavitt.
Topics in ecology and management of landscapes are arranged depending on the interests of students and availability of staff.

NTRES 497(4970) Honors Research in Natural Resources
Fall or spring. 1–6 credits, variable; may be repeated for credit. Prerequisite: enrollment in NTRES honors research program; students must register using independent study form (available in 140 Roberts Hall). NTRES Staff.
Intended for students pursuing the research honors program in natural resources. Students must complete the CALS Honors program application by the third week of the fall semester of their senior year. The research supervisor should be a faculty member or senior research associate within NTRES.

NTRES 498(4980) Teaching in Natural Resources
Fall and spring. 1–4 credits. Prerequisite: permission of instructor. Students must register using independent study form (available in 140 Roberts Hall). S-U or letter grades.
Designed to give students an opportunity to obtain teaching experience by assisting in labs, field trips for designated sections, discussions, and grading. Students gain insight into the organization, preparation, and execution of course plans through application and discussions with instructor.

NTRES 500(5900) Professional Projects—M.P.S.
Fall and spring. Credit TBA. Prerequisite: M.P.S. graduate students working on professional master's projects. S-U grades only.

NTRES 600(6000) Introduction to Graduate Study in Natural Resources
Fall. 2 credits. Prerequisite: beginning graduate students whose faculty advisors are in Natural Resources. S-U grades. C. E. Kraft.
Includes faculty-led discussions of key natural resource issues, student discussions of research ideas, and skill building sessions on proposal writing and giving research presentations. Students are required to complete a research proposal.

NTRES 601(6010) Seminar on Selected Topics in Natural Resources
Fall or spring. 1 credit. S-U grades only. Check with department for availability. Staff.
Selected readings and discussions of research and/or current problems in natural resources. Offering varies by semester and is subject to availability of staff.

NTRES 604(6040) Seminar on Selected Topics in Resource Policy and Management
Fall. 2 credits. S-U grades only. Check with department for availability.

Special topics seminar on subjects related to resource policy and management. Offering varies by semester and is subject to availability of staff.

[NTRES 611(6110) Quantitative Ecology and Management of Fisheries Resources
Spring. 4 credits. Prerequisite: NTRES 313 or permission of instructor. S-U or letter grades. Offered alternate years; next offered 2008–2009. P. J. Sullivan.
Taught in conjunction with NTRES 411 (see description above). Students taking the course for graduate credit are asked, in addition to the 400-level projects and homework, to construct and document a model of population or community dynamics that reflects and extends the concepts covered in the course.]

NTRES 612(6120) Wildlife Population Analysis: Techniques and Models
Spring. 3 credits; two-week intensive course in Jan. Prerequisites: NTRES 310 (or equivalent or permission of instructor), college-level math and statistics course. E. Cooch.
For description, see NTRES 412.

NTRES 614(6140) Fish and Wildlife Ecology Seminar
Fall and spring. 1 credit. Prerequisite: permission of instructor. Check with department for availability. Staff.
Discussion of individual research, current problems, and current literature in fish and in wildlife ecology. Offering varies by semester and subject to availability.

NTRES 616(6160) Forest Science and Management Seminar
Fall. 1 credit. Prerequisite: upper-level undergraduate or graduate standing. J. B. Yavitt.
Reviews current literature, student research, and selected topics of interest. Topics include biogeography, ecology, and human use of forests located in boreal, temperate, and/or tropical environments.

NTRES 628(6280) Principles and Practices of Applied Wildlife Science
Spring. 3 credits. Prerequisites: NTRES 310 or equivalent; permission of instructor. S-U or letter grades. Offered alternate even-numbered years. M. E. Richmond, R. A. Malecki, and P. D. Curtis.
For description, see NTRES 428.

[NTRES 630(6300) Writing for the Biological Sciences
Spring. 2 credits. Prerequisites: graduate students in writing phase of their thesis or dissertation or involved in preparation of manuscripts for submission to scientific journals. S-U or letter grades. Offered alternate odd-numbered years. R. A. Malecki and M. E. Richmond.
This course is designed for graduate students interested in learning to convey scientific information in a clear and concise manner. Attention is given to format requirements for theses and manuscripts, submission and editorial policies of scientific journals, construction of sentences and paragraphs, grammar, punctuation, word usage, development of figures and tables, and use of literature. Come prepared to write, rewrite, and edit.]

NTRES 631(6310) Environmental Governance (also D SOC 632[6320])
Spring. 4 credits. S. Wolf.
For description, see NTRES 331. Students taking the course for graduate credit are required to read supplemental materials, undertake more complex research assignments, and participate in seminar discussion section.

NTRES 634(6340) International Conservation: Communities and the Management of the World's Natural Resources
Fall. 3 credits, variable. Prerequisite: graduate standing. Letter grades only. Offered alternate odd-numbered years. J. P. Lassoie.
For description, see NTRES 434. Students taking the course for graduate credit will be required to identify and critically review additional literature and participate in a one-hour discussion seminar per week (TBA).

NTRES 670(6700) Spatial Statistics
Spring. 3 credits. Prerequisites: BTRY 601 and 602. Highly recommended: introductory GIS course. S-U or letter grades. Offered alternate years. P. J. Sullivan.
Develops and applies spatial statistical concepts and techniques to ecological and natural resource issues. Topics include visualizing spatial data and analysis and modeling of geostatistical, lattice, and spatial point processes. Students should consider taking this course simultaneously with CSS 620.

NTRES 694(6940) Special Topics in Natural Resources
Fall or spring. 4 credits max. S-U or letter grades.
The department teaches "trial" courses under this number. Offerings vary by semester, and are advertised by the department before the semester starts. Courses offered under the number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

NTRES 696(6960) Agroecological Perspectives for Sustainable Development (also IARD/CSS 696[6960])
Fall and spring. 1 credit. S-U grades only. L. Buck, L. Fisher, and S. DeGloria.
For description, see IARD 696.

NTRES 699(6990) Graduate Individual Study in Natural Resources
Fall or spring. Credit TBA. Prerequisite: permission of instructor. S-U or letter grades. NTRES graduate faculty.
Study of topics in natural resources more advanced than, or different from, other courses. Subject matter depends on interests of students and availability of staff.

NTRES 780(7800) Graduate Seminar in Ornithology (also BIOEE 780[7800])
Fall or spring. 1 credit. S-U grades only. Undergraduates must have permission of instructor. J. Dickinson, I. Lovette, A. Dhondt, and D. Winkler.
Group intensive study of current research in ornithology. Topics vary from semester to semester. Course may be repeated for credit.

NTRES 800(8900) Master's Thesis Research
Fall and spring. Credit TBA. Prerequisite: graduate students working on master's thesis research. S-U grades only.

NTRES 900(9900) Graduate-Level Thesis Research
Fall and spring. Credit TBA. Prerequisite: Ph.D. students **before** "A" exam has been passed. S-U grades only.

NTRES 901(9910) Doctoral-Level Thesis Research
Fall and spring. Credit TBA. Prerequisite: Ph.D. candidates after "A" exam has been passed. S-U grades only.

Related Courses in Other Departments

Courses in many other departments are relevant to students majoring in natural resources. The following list includes some of the most closely related courses but is not exhaustive.

Environment and Society (D SOC 324, 340, 410)

Ecology and Biology (ENTOM 370, 470; BIOEE 261, 263, 274, 278, 450, 457, 459, 462, 463, 465, 466, 468, 472, 475, 476, 478; BIOMI 290–292, 397, 418; CSS 466, 472; EAS 154, 350, 351)

Environmental Law, Ethics, and Philosophy (S&TS 206; CRP 380, 443, 444, 451, 453; PHIL 241, 246, 247, 381)

Human Systems and Communication (COMM 260, 285, 352, 421)

Physical Sciences (BEE 151, 371, 401, 427, 435, 471, 473, 475, 478; CSS 260, 365, 372, 397, 410, 421, 483; EAS 102, 104, 154, 201, 240, 268, 303; CEE 432)

Public Policy and Politics (GOVT 427, 428; B&SOC 461)

Resource Economics (AEM 250, 450, 451)

Spatial Data Interpretation (CSS 411, 420, 465, 620, 660)

PLANT BREEDING AND GENETICS

T. Brutnell, E. S. Buckler, W. R. Coffman, W. De Jong, J. J. Doyle, E. D. Earle, V. Gracen, P. Gregory, A. F. Krattiger, S. Kresovich, M. M. Jahn, L. Li, S. R. McCouch, M. A. Mutschler, R. J. Nelson, W. Pawlowski, K. V. Raman, T. L. Setter, F. Shotkoski, M. E. Smith, M. E. Sorrells, S. D. Tanksley, D. R. Viands. Emeritus: R. E. Anderson, H. M. Munger, R. P. Murphy, W. D. Pardee, R. L. Plaisted

PL BR 201(2010) Plants, Genes, and Global Food Production
Fall. 3 credits. May be used for partial fulfillment of CALS distribution requirement Physical and Life Sciences. Prerequisite: one year introductory biology or permission of instructor. S. McCouch.
Introduction to plant breeding; offers a sense of the importance of the field, tracing its evolution from the pre-scientific days of crop domestication to modern applications of biotechnology. Offers examples of how breeding objectives are realized and raises

questions about the environmental, social, and economic consequences of intensive food production systems. Emphasizes the connection between the genetics of plants, modern scientific research, and the potential to respond to the growing human demand for food, fiber, fuel, and environmental sustainability.

PL BR 225(2250) Plant Genetics
Spring. 3 or 4 credits; 2 credits if taken after BIOGD 281. Prerequisites: one year of introductory biology or equivalent; permission of instructor for students who have taken BIOGD 281. S. Naithani.
Surveys the fundamentals of plant genetics and shows how this information is used in plant biology and allied agricultural sciences and provides a basis for understanding the complex issues related to modern crop genetics. Topics include simple inheritance; linkage analysis; polyploidy; analysis of nuclear, chloroplast and mitochondrial genomes; pollination controls; and methods for analysis and manipulation of genes, chromosomes, and whole genomes. Examples and materials are drawn from diverse crops and plant species.

PL BR 299(2990) Introduction to Research Methods in Plant Breeding and Genetics
Fall, spring, or summer. 1–3 credits, variable. S-U grades only. Staff.
Intended for students who are new to undergraduate research. Students may be reading scientific literature, learning research techniques, or assisting with ongoing research. Students must identify a faculty supervisor who determines the work goals and the form of the final report.

PL BR 300(3000) Introduction to Genomics
Fall. 3 credits. Prerequisites: BIOGD 281, PL BR 225. S-U or letter grades.
S. Naithani and M. Devare.
This course will introduce students to the developments in the field of genomics, and cover concepts and research methods used to accumulate and analyze genomic data, functional and structural homology, and gene expression. The course includes hands-on computer lab sessions to familiarize students with the use of databases and visits to genomic facilities.

PL BR 401(4010) Plant Cell and Tissue Culture
Fall. 3 credits. Prerequisite: plant biology or genetics course or permission of instructor. E. D. Earle.
Provides broad coverage of techniques of plant tissue, cell, protoplast, embryo, and anther culture and the applications of those techniques to biological and agricultural studies. Examples include horticultural, agronomic, and endangered species. Genetic modification of plants via gene transfer and other manipulations of cultured cells is a major topic.

PL BR 402(4020) Plant Tissue Culture Laboratory
Fall. 1 credit. Limited enrollment. Pre- or corequisite: PL BR 401 or permission of instructor. E. D. Earle.
Provides hands-on experience in plant tissue culture and complements PL BR 401. Lab work includes cell, tissue and organ culture techniques related to plant propagation, germplasm storage, and genetic manipulations. Experiments use a broad range of plant materials and include protoplast culture and *Agrobacterium*-mediated gene transfer.

PL BR 403(4030) Genetic Improvement of Crop Plants
Fall. 3 credits. Prerequisites: BIOGD 281, PL BR 225, or other standard genetics course and course in crops or horticulture. V. Gracen.
Genetic enhancement of crop value to humans began with domestication and continues with farmers' variety development and scientifically trained plant breeders' applications of Mendelian, quantitative, and molecular genetics. This course examines crop genetic improvement methods by discussing the history and current practice of plant breeding, tools available to breeders, choices and modifications of those tools to meet specific objectives, and challenges plant breeders face in developing varieties for the future.

PL BR 404(4040) Crop Evolution, Domestication and Diversity (also BIOPL/IARD 404[4040])
Fall. 2 credits. Prerequisite: BIOGD 281 or PL BR 225 or permission of instructor. S-U or letter grades. S. Kresovich.
Evolution, domestication, and breeding of crop plants have molded the current diversity we conserve and use. Based on advances in systematics and molecular genetics, this course presents an integrated approach to understanding and describing diversity of agricultural and horticultural species. Also addresses underlying ethical, legal, and social issues affecting conservation and use.

PL BR 405(4050) Patents, Plants, and Profits: Intellectual Property Management for Scientists and Entrepreneurs (also IARD 405[4050])
Spring. 2 credits. Prerequisite: senior or graduate standing. S-U or letter grades.
A. F. Krattiger and S. Kowalski.
Covers statutory protection (copyright, trademarks, patents, plant variety protection), contracts (from material transfer to licensing), management of IP (e.g., freedom-to-operate, valuation, genetic resources, trade, and marketing), and negotiation. Emphasizes technology transfer and international aspects. The course is particularly relevant to students interested in science management, technology transfer, international agriculture, and business.

PL BR 406(4060) Methods of Plant Breeding Laboratory
Fall. 2 credits. Pre- or corequisite: PL BR 403 or equivalent. S-U or letter grades.
M. E. Sorrells.
Field trips to plant breeding programs involve discussion of breeding methods used, overall goals, selection and screening techniques, and variety and germplasm release.
Additional labs include selection techniques for various traits, intellectual property issues, genetically modified crops, and international agriculture. For a term project, each student designs a comprehensive breeding program on a chosen crop.

PL BR 446(4460) Plant Cytogenetics Laboratory
Spring, two-week module. 1 credit. S-U grades only. Prerequisite: genetics course or permission of instructor. Check with department for further information.
K. N. Watanabe.
Aims to provide fundamental knowledge and techniques in plant cytogenetics. Emphasizes applications to research on plant genetics and plant breeding. Plant materials involve a wide range of crop species. Covers basic techniques for examination of plant chromosomes.

PL BR 482 Plant Biotechnology (also BIOPL 482.6)
Spring. 1 credit. Prerequisite: BIOPL 483.1 or permission of instructor. S-U or letter grades. 12 lec. E. D. Earle.
Deals with current and proposed use of transgenic plants for agricultural and industrial purposes. Topics include procedures for gene introduction and control of gene expression, as well as strategies for obtaining transgenic plants that are resistant to insects, diseases, and herbicides, or have improved nutritional or processing characteristics. Other topics are use of transgenic plants for production of valuable products and for environmental remediation. Biosafety, social, legal, and international issues relating to plant biotechnology are discussed.

PL BR 483.1 Concepts and Techniques in Plant Molecular Biology (also BIOPL 483.1, PL PA 463.01)
Fall, eight weeks. 2 credits. Prerequisites: see BIOPL 483. S-U or letter grades. Two lec and one day of disc per week.
S. McCouch, J. Giovannoni, and J. Rose.
For description, see BIOPL 483.1.

[PL BR 483.3 Plant Genome Organization (also BIOPL 483.3)
Fall. 1 credit. Prerequisite: BIOPL 483.1. S-U or letter grades. Offered alternate years; next offered 2008–2009.
S. D. Tanksley.
For description, see BIOPL 483.3.]

PL BR 483.5 Molecular Breeding (also BIOPL 483.5)
Fall. 1 credit. S-U or letter grades. Offered alternate years. S. Tanksley.
For description, see BIOPL 483.5.

PL BR 494(4940) Special Topics in Plant Breeding
Fall or spring. 4 credits max. S-U or letter grades.
The department teaches "trial" courses under this number. Offerings vary by semester, and are advertised by the department before the semester starts. Courses offered under the number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

PL BR 496(4960) Internship in Plant Breeding
Fall or spring. Variable credit; may be repeated to max. of 6; minimum 60 on-the-job hours per credit granted. Prerequisites: junior or senior in plant breeding; minimum GPA of 3.0 in plant breeding courses; permission of advisor and enrollment during pre-enrollment period of semester before internship. S-U grades only. Students must attach to their course enrollment materials a CALS

independent study, research, teaching, or internship form signed by faculty member who will supervise study and assign credits and grade. Staff.

On-the-job learning experience under the supervision of professionals in a cooperating organization. A learning contract is written between the faculty supervisor and student, stating the conditions of the work assignment, supervision, and reporting.

PL BR 497(4970) Individual Study in Plant Breeding
Fall or spring. Variable credit; may be repeated to max. of 6. Prerequisite: permission of instructor. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall). Staff.

PL BR 498(4980) Undergraduate Teaching
Fall or spring. Variable credit; may be repeated to max. of 6. S-U or letter grades. Prerequisites: permission of instructor and previous enrollment in course to be taught or equivalent. Students must register using independent study form (available in 140 Roberts Hall). Staff.

Undergraduate teaching assistance in a plant breeding course. Teaching experience may include leading a discussion section, preparing and teaching laboratories, and tutoring.

PL BR 499(4990) Undergraduate Research
Fall or spring. Variable credit. Prerequisite: permission of instructor. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall). Staff.

Undergraduate research projects in plant breeding.

PL BR 606(6060) Advanced Plant Genetics
Spring. 3 credits. Prerequisites: BIOGD 281 or equivalent and permission of instructor. S-U or letter grades. W. Pawlowski.

Advanced survey of genetics in higher plants including selected topics in transmission genetics, epigenetics, and chromosome biology. Emphasizes development of critical analytical skills through reading of current literature and a class project

[PL BR 618(6180) Breeding for Pest Resistance (also HORT 618[6180])]
Fall. 2 credits. Prerequisites: BIOGD 281 and PL BR 403 or equivalents. Highly recommended: introductory course in plant pathology and/or entomology. Offered alternate even-numbered years; next offered 2008–2009. P. Griffiths.

Multidisciplinary examination of the challenge of incorporating disease and insect resistance into crop plants. Topics include national and international germplasm collections, germplasm evaluation and enhancement, resistance mechanisms in plants, monogenic and polygenic control of resistance, approaches to breeding for resistance, stability of genetic resistance mechanisms, and the use of biochemical, physiological, and molecular tools in breeding for pest resistance.]

PL BR 622(6220) Seminar
Fall or spring. 1 credit. S-U grades only. Staff, graduate students, and visitors.

PL BR 650(6500) Special Problems in Research and Teaching
Fall or spring. 1 or more credits. Prerequisite: permission of instructor supervising research or teaching. Staff.

PL BR 694(6940) Special Topics in Plant Breeding
Fall or spring. 4 credits max. S-U or letter grades.

The department teaches "trial" courses under this number. Offerings vary by semester, and are advertised by the department before the semester starts. Courses offered under the number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

[PL BR 716(7160) Perspectives in Plant Breeding Strategies
Spring. 3 credits. Prerequisite: PL BR 403. S-U or letter grades. Offered alternate odd-numbered years; next offered 2008–2009. M. E. Sorrells.

Emphasizes critical discussion and evaluation of selected benchmark papers and current literature. Reviews and discusses conventional and molecular selection techniques and breeding objectives, methods, and strategies for both self- and cross-pollinated crops. Requires extensive outside reading. Grades are based on four papers demonstrating creative thinking and analysis of plant breeding concepts.]

PL BR 717(7170) Quantitative Genetics in Plant Breeding
Spring. 3 credits. Prerequisites: PL BR 403 and BTRY 601 or equivalent. S-U or letter grades. Offered even-numbered years. D. R. Viands.

Discussion of quantitative genetics for more effective plant breeding. Specific topics include population genetics, linkage, components of variance (estimated from various mating designs); heritability; theoretical gain from selection; and genotypic and phenotypic correlation coefficients. During one period, plants in the greenhouse are evaluated to provide data for computing quantitative genetic parameters.

PL BR 800(8900) Master's-Level Thesis Research
Fall or spring. Variable credit. Prerequisite: master's candidates; permission of instructor. S-U grades. Graduate faculty.

For students working on a master's thesis.

PL BR 900(9900) Graduate-Level Dissertation
Fall or spring. Variable credit. Prerequisite: doctoral students who have not passed "A" exam; permission of instructor. S-U grades. Graduate faculty.

PL BR 901(9910) Doctoral-Level Dissertation Research
Fall or spring. Variable credit. Prerequisite: doctoral students who have passed "A" exam; permission of instructor. S-U grades. Graduate faculty.

For students admitted to candidacy **after** "A" exam has been passed.

PLANT PATHOLOGY

G. W. Hudler, chair (331 Plant Science Bldg., 255-7848); S. V. Beer, G. C. Bergstrom, S. Cartinour, A. R. Collmer, W. E. Fry, S. M. Gray, K. T. Hodge, S. G. Lazarowitz, K. Lee, J. W. Lorbeer, R. Loria, G. B. Martin, M. T. McGrath, M. G. Milgroom, E. B. Nelson, R. J. Nelson, T. Pawlowska, K. L. Perry, B. G. Turgeon, X. Wang, T. A. Zitter

PL PA 110(1100) Symbiotic Associations in Nature
Fall or spring. 3 credits. E. B. Nelson.

This course is a Freshman Writing Seminar where students will explore symbiotic biology and the nature of science and written scientific communication through discussions of a broad range of symbiotic relationships. Students will be exposed to a broad range of writing styles in scientific communication. Students will gain experience writing in a number of styles common in the biological sciences. Additionally, students will learn to use evidentiary and inferential reasoning, articulate their thoughts and ideas through writing, make logical and systematic arguments, learn to revise their own writing and effectively critique others' writing content, organization, and style.

PL PA 120(1200) Evolution: Evaluating the Public Debate
Spring or fall. 3 credits. R. Loria.

Though we live in a world infused with science and technology, most of the general public and a significant number of Cornell students do not believe in evolution. Evolution, the theory that organisms are connected by genealogy and change over time, is well supported and accepted as true by the scientific community. Nevertheless, there is an emotional debate outside scientific circles about the legitimacy of evolution as an explanation for the diversity of life on earth, and the existence of humans in particular. Readings will include books and articles that address the evidence for evolution. We will also analyze the writings of proponents of "Intelligent Design" and study descriptions of the controversy in the popular press, both current and historical.

PL PA 201(2010) Magical Mushrooms, Mischievous Molds
Spring. 2 credits. S-U or letter grades. G. W. Hudler.

Presentation of the fungi and their roles in nature and in shaping past and present civilizations. Emphasizes the historical and practical significance of fungi as decayers of organic matter, as pathogens of plants and animals, as food, and as sources of mind-altering chemicals.

PL PA 301(3010) Biology and Management of Plant Diseases
Fall. 4 credits. Prerequisite: one year of biology. M. G. Milgroom.

Introduction to the biology of the pathogens that cause plant diseases, and the diagnosis and management of plant diseases. Topics include the biology of bacteria, fungi, oomycetes, viruses and nematodes; disease cycles, plant disease epidemiology, and the principles and practices of plant disease management. Intended for students who want a practical knowledge of plant diseases and their control, as well as for students preparing for advanced courses in plant pathology and plant–microbe biology.

PL PA 309(3090) Fungi
Fall. 3 credits. Prerequisite: one year of biology. Recommended: concurrent enrollment in PL PA 319. K. T. Hodge.
A thorough introduction to the astounding kingdom of fungi, including mushrooms, molds, yeasts, athlete's foot, histoplasmosis, and the blue stuff in blue cheese. We cover fungal biodiversity, how fungi work, and their roles in the environment and in human affairs. Students work with living and preserved fungi and learn basic lab and identification skills.

PL PA 319(3190) Mushrooms of Field and Forest
Fall, weeks 1–8. 2 credits. Letter grades only. K. T. Hodge.
Students learn to identify mushrooms and other macrofungi on a series of eight field trips to local forests. Mushrooms are collected during afternoon lab field trips. During the evening labs, students use keys and microscopes to identify mushrooms they've collected, and brief lectures introduce fungal ecology and diversity. Students must attend both lab times.

PL PA 394(3940) Circadian Rhythms (also ENTOM 394[3940], BIOGD/BIONB 394[3940])
Fall. 2 credits; optional 3rd-credit lab. Prerequisite: 200-level biology. S-U or letter grades. K. Lee.
Explores a fundamental feature of living organisms from all kingdoms: how the cellular 24-hour biological clock operates and influences biological activities. Covers fundamental properties of biological rhythms and cellular and molecular structure of circadian oscillators in many organisms including cyanobacteria, fungi, insects, plants, reptiles, birds, and mammals (including humans).

PL PA 409(4090) Principles of Virology (also VETMI/BIOMI 409[4090])
Fall. 3 credits. Prerequisites: BIOMI 290, 291 or permission of instructor. Recommended: BIOBM 330–332, 432. Letter grades only. G. R. Whittaker and S. G. Lazarowitz.
For description, see VETMI 409.

PL PA 411(4110) Plant Disease Diagnosis
Fall. 3 credits. Limited to 18 students. Prerequisites: PL PA 301 or equivalent and permission of instructor. Staff.
Teaches a method of diagnosing plant diseases caused by infectious and noninfectious agents with emphasis on application of contemporary laboratory techniques and effective use of the literature. After seven weeks of formal lecture and laboratory sessions, students spend the rest of the semester working on their own to determine the causes of plant diseases on samples that have either been received by the Plant Disease Diagnostic Lab or that have been prepared by instructors.

PL PA 419(4190) Agricultural Application of Plant Disease Concepts
Fall. 2 credits. Eight sessions. Prerequisite: PL PA 301 **and** permission of instructor. S-U or letter grades. H. S. Aldwinckle and J. P. Nyrop.
Addresses real-world problems in plant pathology and entomology through the application of research. Students tour fields of diverse fruit and vegetable field crops, a nursery, forests, and a golf course that have been impacted by diseases and arthropod pests. Strategies for managing diseases and pests based on research and the interface between Research and Extension are emphasized. **This course is taught at Geneva. Free transportation available.**

PL PA 420(4200) Grape Pest Management (also ENTOM 420[4200])
Fall. 3 credits. Prerequisite: PL PA 301, ENTOM 241, or permission of instructors. S-U or letter grades. W. Wilcox, G. English-Loeb, and A. Landers.
The course emphasizes general integrated pest management concepts, the biology and specific management practices pertaining to the major diseases and arthropod pests of grapes, and modern spray application technologies. Laboratories emphasize field illustrations of classroom concepts. Team taught by a plant pathologist, entomologist, and agricultural engineer.

[PL PA 443(4430) Pathology and Entomology of Trees and Shrubs (also ENTOM 443[4430])
Fall. 4 credits. Limited to 30 students. Prerequisites: PL PA 301 or equivalent, ENTOM 212 or equivalent. Offered even-numbered years; next offered 2008–2009. G. W. Hudler.
For students preparing for careers in horticulture, urban forestry, natural resources, and pest management. Deals with identification, impact, assessment, biology, and management of insects and diseases that damage trees and shrubs. Emphasizes pests of northeastern flora but examples from other parts of the country and the world are also used. Considers forest, shade, and ornamental plants.]

PL PA 448(4480) Evolution and Ecology of Symbiotic Associations
Spring. 2 credits. Prerequisites: BIO G 101-102 or equivalent. Letter grades only. T. Pawlowska.
Symbiosis, a living together of two organisms in close associations, encompasses a spectrum of interactions ranging from mutually detrimental to mutually beneficial. We are going to focus on a selection of ecologically important symbiotic interactions, consider their evolutionary origins, and explore conditions that would favor their establishment and maintenance.

PL PA 462.1(4620.1) Molecular Plant-Pathogen Interactions I and II (also BIOPL 482.1)
Spring. 1 credit. Jan. 22–Feb. 16 (12 lec). Prerequisites: BIOGD 281, BIOBM 330 or 331, and BIOPL 483.1. A. R. Collmer and B. G. Turgeon (odd years); S. G. Lazarowitz and G. B. Martin (even years).
Examines the molecular and cellular factors that control pathogen-plant interactions from the perspectives of pathogen biology and plant responses to pathogen infection. Beginning spring 2004, alternate years will focus on (1) plant perception of microbial pathogens and the interplay of plant defenses and pathogen counterstrategies that result in resistance or susceptibility to disease production, with topics including the genetic nature of dominant and recessive resistance, induction of pathogen defense genes, apoptotic responses that limit infection, and RNA interference; and (2) the genetic and molecular mechanisms of microbial pathogenesis, with an emphasis on fungal and bacterial virulence proteins, toxins, and their deployment systems.

PL PA 462.2(4620.2) Plant Biotechnology (also BIOPL 482.2, PL BR 482)
Spring. 1 credit. 12 lec. E. D. Earle.
Deals with production and uses of transgenic plants for agricultural and industrial purposes. Topics include procedures for gene introduction and control of gene expression, as well as strategies for obtaining transgenic plants that are resistant to insects, diseases, and herbicides; produce useful products; or have improved nutritional and food processing characteristics. Discusses regulatory and social issues relating to plant biotechnology.

PL PA 463(4630) Plant Molecular Biology 1
Fall. 1–5 credits. Prerequisite: BIOGD 281, BIOBM 330 or 331.

Sec 01 Concepts and Techniques in Plant Molecular Biology (also BIOPL/PL BR 483.1)
2 credits. 12 lec. J. J. Giovannoni, S. R. McCouch, and J. Rose.
For description, see BIOPL 483.1.

PL PA 464(4640) Molecular Plant-Microbe Interactions (also BIOPL 482.2/BIOMI 482.2)
Spring. 1 credit. Jan. 21–Feb. 15 (12 lec). Prerequisites: BIOGD 281, BIOBM 330 or 331 or 333, and BIOPL 483.1 or equivalents. S-U or letter grades. Offered even-numbered years. S. C. Winans.
For description, see BIOPL 482, sec 2.

PL PA 470(4700) Professional Skills in Plant Science
Fall. 2 credits. S-U grades only. E. B. Nelson.
Provides students who are aspiring to careers as research plant scientists with an overview of the art and science of the profession. Topics include (1) what it means to be a scientist and plant pathologist; (2) preparation required of graduate students in plant pathology programs; (3) ethical considerations important to plant pathologists; (4) how to seek funding to support research activities; (5) managing the scientific literature; (6) funneling curiosity into scientific inquiry; and (7) how to read a scientific paper. Students in related disciplines (e.g., horticulture, plant breeding, plant biology) also benefit from concepts presented in this course.

PL PA 494(4940) Special Topics in Plant Pathology
Fall or spring. 4 credits max. S-U or letter grades. Staff.
The department teaches "trial" courses under this number. Offerings vary by semester, and are advertised by the department before the semester starts. Courses offered under the number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

PL PA 497(4970) Independent Study
Fall or spring. 1–5 credits. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall).
An opportunity for independent study of a special topic in mycology or plant pathology under the direction of a faculty member.

PL PA 498(4980) Teaching Experience
Fall or spring. 1–5 credits. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall).
Undergraduate teaching assistance in a mycology or plant pathology course by mutual agreement with the instructor.

PL PA 499(4990) Undergraduate Research
Fall or spring. 3–5 credits. S-U or letter grades. Students must register using independent study form (available in 140 Roberts Hall).
Opportunity for research experience under the direction of a faculty member.

PL PA 601(6010) Concepts of Plant Pathology
Spring. 3 credits. Prerequisites: PL PA 301 or equivalent. S-U or letter grades. A. R. Collmer.
Concepts in plant-pathogen relationships uniting molecular and population biology approaches, with emphases on molecular/cellular investigations of model pathosystems and population biology studies integrating host-pathogen evolution, genetics, and ecology. The discussion section is used for examining current research literature and other exercises complementary to lecture topics; emphasis is on critical thinking in science. Students prepare and review mock grant proposals.

PL PA 602(6020) Biology of Plant Pathogens
Spring. 3 credits. Prerequisite: PL PA 301. Recommended: PL PA 601 as corequisite. W. E. Fry and K. L. Perry.
Biology and ecology of four major groups of plant pathogens: fungi, bacteria, viruses, and oomycetes. Model plant pathogens are used to illustrate concepts of pathogen diversity, evolution, reproduction, life cycles, movement, diagnosis, and control. Lecture and laboratory topics are coordinated with PL PA 601 to provide students with a comprehensive treatment of pathogen–host interactions at all levels from molecular to ecological. Laboratory periods are used for hands-on demonstration of pathogen diagnosis and manipulation or to discuss current literature relevant to lecture topics.

[PL PA 606(6060) Molecular Plant Virology (also BIOMI 650[6500])
Spring, 7 weeks, first half of semester. 1 credit. Prerequisites: BIOMI 409 or equivalent or permission of instructor. S-U or letter grades. Offered odd-numbered years; next offered 2008–2009. S. G. Lazarowitz.
Introduces students to the molecular biology of plant virus replication and interactions with the host to produce disease. Topics include virus replication strategies, cell-to-cell and systemic movement, host defense responses and virus counterstrategies, and engineered resistance.]

[PL PA 608(6080) Genomics of Bacterium-Host Interactions (also BIOMI 608[6080])
Fall, second half of semester. 1 credit. Prerequisite: BIOMI 290 or equivalent or permission of instructor. S-U or letter grades. Offered even-numbered years; next offered 2008–2009. A. R. Collmer and S. C. Winans.
Introduction to genomic approaches, tools, and discoveries involving the study of bacterial interactions with plant and animal hosts. Topics include the TIGRE Comprehensive Microbial Resource and Artemis tools, the pathogens *Yersinia pestis, V. enterocolitica, Pseudomonas syringae, Ralstonia solanacearum,* and *Agrobacterium tumefaciens,* and the symbiont *Sinorhizobium meliloti.*]

PL PA 625(6250) Evolution and Ecology of Mutualisms
Fall. 1 credit. S-U grades only. T. Pawlowska.
Mutualisms are mutually beneficial interactions between species. Despite their ubiquity, the understanding of evolution and ecology of mutualisms is surprisingly limited. We are going to explore the conceptual framework explaining the establishment and maintenance of mutualisms and examine whether the empirical findings from various interactions support the theoretical predictions.

[PL PA 638(6380) Filamentous Fungal Genomics and Development (also BIOGD 638[6380])
Spring, last four weeks of semester. 1 credit. Prerequisite: BIOGD 281 or equivalent. S-U or letter grades. Offered odd-numbered years; next offered 2008–2009. B. G. Turgeon.
Molecular genetic and genomic approaches to the study of fungal biology. Applications of contemporary methodology to genetic dissection of developmental processes, such as pathogenesis and reproduction, are described and experimental data are evaluated. Examples are chosen from investigations of model plant pathogenic fungi such as *Cochliobolus heterostrophus, Fusarium graminearum, Magnaporthe grisea,* and *Ustilago maydis* and from well-known genetic models such as *Aspergillus nidulans* and *Neurospora crassa.*]

PL PA 642/652(6420/6520) Special Topics Series
Unless otherwise indicated, the following description applies to PL PA 642–652. Fall or spring. 1 credit. Prerequisite: permission of instructor. S-U grades only.
Weekly discussions of current topics in special areas of plant pathology and mycology. Students are required to do extensive reading of current literature and to present oral and written reports.

PL PA 642(6420) Pathogen Population Biology
Fall. M. G. Milgroom.

PL PA 644(6440) Current Topics in Oomycete Biology
Fall. E. B. Nelson.

PL PA 645(6450) Plant Virology
Fall. S. M. Gray.

PL PA 647(6470) Phytobacteriology Research Updates
Fall and spring. S. V. Beer.
Emphasizes current research in phytobacteriology undertaken in laboratories at Cornell.

PL PA 649(6490) Fungal Biology
Spring. 1 credit. Recommended: some background in mycology or plant pathology. K. T. Hodge and B. G. Turgeon.
Weekly meeting to discuss current scientific articles on the biology of fungi. Primarily directed at graduate students, but undergraduates, postdocs, staff, and guests who have an interest in fungi are welcome.

PL PA 650(6500) Diseases of Vegetable Crops
Fall. 1 credit. S-U grades only. J. W. Lorbeer and T. A. Zitter.

PL PA 652(6520) Field Crop Pathology
Spring. 1 credit. W. G. C. Bergstrom.

PL PA 660(6600) Special Topics in Plant Disease Management
Fall and spring. 1 credit. S-U grades only. C. D. Smart.
Weekly discussions of current topics in plant disease management. These include not only management practices, but also factors that influence management strategies. Students are required to read current literature and present oral reports on a topic. **Offered only at the Geneva campus. Students provide their own transportation.**

PL PA 661(6610) Diagnostic Lab Experience
Fall and spring. 1 or 2 credits. Priority given to graduate students in plant pathology and plant protection. Recommended: course work or experience in diagnostic techniques. S-U grades only. Requires 3 hours per week per credit hour. T. A. Zitter.
For graduate students and advanced undergraduates with a special interest in diagnosing plant diseases. Students work in the Diagnostic Laboratory (plant pathology department) under supervision of the diagnostician.

PL PA 681(6810) Plant Pathology Seminar
Fall and spring. 1 credit. Requirement for all plant pathology majors. S-U grades only. B. G. Turgeon.

PL PA 682(6820) Graduate Student Research Updates
Spring and fall. 1 credit. Requirement for all Plant Pathology graduate students. S-U grades only. S. Cartinhour and H. Aldwinckle.
Weekly graduate student seminar series. Guests with an interest in plant pathology research are welcome to attend. Classes meet simultaneously in Geneva and Ithaca and are linked by teleconference.

PL PA 694(6940) Special Topics in Plant Pathology
Fall or spring. 4 credits max. S-U or letter grades. Staff.
The department teaches "trial" courses under this number. Offerings vary by semester, and are advertised by the department before the semester starts. Courses offered under the number will be approved by the department curriculum committee, and the same course is not offered more than twice under this number.

PL PA 788(7880) Research in Molecular Plant Pathology
Fall and spring. 2, 4, or 6 credits. Prerequisite: permission of instructor before beginning research.
S-U grades only. S. V. Beer.
Guided research experiences in laboratories addressing questions concerning the interaction of pathogens (bacteria, fungi, viruses) and plants at the molecular level. Intended for beginning graduate students with a concentration in molecular plant pathology and sufficient theoretical background and practical laboratory experience. Students submit plans and reports on each research experience.

PL PA 797(7970) Special Topics
Fall or spring. 1–5 credits. S-U or letter grades. Staff.
Opportunity for independent study of a special topic.

PL PA 798(7980) Graduate Teaching Experience
Fall or spring. 1–5 credits. S-U grades. Staff.
Graduate teaching assistance in a mycology or plant pathology course by mutual agreement with the instructor. This experience may include, but is not limited to, preparing, assisting in, and teaching laboratories, preparing and delivering lectures, leading discussion sessions, and tutoring.

PL PA 800(8900) Master's-Level Thesis Research
Fall or spring. Credit TBA. S-U or letter grades. Prerequisite: permission of advisor. Graduate faculty.
For students working on a master's degree.

PL PA 900(9900) Graduate-Level Thesis Research
Fall or spring. Credit TBA. S-U or letter grades. Prerequisite: permission of advisor. Graduate faculty.
For Ph.D. students who have not passed "A" exam.

PL PA 901(9910) Doctoral-Level Thesis Research
Fall or spring. Credit TBA. S-U or letter grades. Prerequisite: permission of advisor. Graduate faculty.
For Ph.D. candidates who have passed "A" exam.

SCIENCE OF NATURAL AND ENVIRONMENTAL SYSTEMS

S. J. Colucci, J. Elliot, G. W. Evans, T. J. Fahey, A. S. Flecker, C. C. Geisler, C. Goodale, C. J. Lehmann, E. L. Madsen, I. Merwin, E. B. Nelson, M. J. Pfeffer, G. P. Poe, S. J. Riha, C. W. Scherer, W. D. Schulze, N. R. Scott, J. Thies, P. J. Trowbridge, D. W. Wolfe, J. B. Yavitt

SNES 101(1010) Intro to the Science and Management of Environmental and Natural Resources (also NTRES 101[1010])
Fall. 3 credits. Prerequisite: first-year students in Natural Resources, Science of Natural and Environment Systems, or other "environmental cluster" areas in CALS. J. Lassoie and E. Madsen.
For description, see NTRES 101.

SNES 200(2000) Environmental Sciences Colloquium
Fall. 1 credit. S-U grades only. S. Riha and J. Lehmann.
This colloquium consists of a series of lectures on an annually changing theme central to the Environmental Sciences, which poses biophysical, economical and political challenges to modern society. Participants will become familiar with contemporary issues of environmental degradation and opportunities for their mitigation. The colloquium is mandatory for SNES majors and is open to the public.

FACULTY ROSTER

Abawi, George S., Ph.D., Cornell U. Prof., Plant Pathology (Geneva)
Acree, Terry E., Ph.D., Cornell U. Prof., Food Science, and Technology (Geneva)
Adleman, Marvin I., M. L. A., Harvard U. Prof., Landscape Architecture
Agnello, Arthur M., Ph.D., North Carolina State U. Prof., Entomology (Geneva)
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Albright, Louis D., Ph.D., Cornell U. Prof., Biological and Environmental Engineering
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