BIOLOGICAL SCIENCES

The biology major provides a unified curriculum for undergraduates enrolled in either the College of Agriculture and Life Sciences or the College of Arts and Sciences. Courses in biological sciences are integral to many disciplines and are basic requirements in many schools and colleges at Cornell.

Graduate study in the biological sciences is administered by more than a dozen specialized fields within the Graduate School, as described in the Announcement of the Graduate School.

ORGANIZATION

Many different departments participate in the biology major.

Student services are provided by the Office of Undergraduate Biology (OUB), www.bio.cornell.edu, which includes the Behrman Biology Advising Center. Co-located in Stimson Hall, the professional and student advisers provide academic and career advising, as well as help undergraduates find research opportunities on campus. Advisers in the OUB also follow the progress of biology majors and work closely with faculty advisers. Additional services and resources of the Biology Center include tutoring, lecture tapes, examination files, and extensive information on summer research opportunities and graduate programs. The center has comfortable areas for studying and relaxing.

The Shoals Marine Laboratory, a cooperative venture with the University of New Hampshire, is located on Appledore Island in the Gulf of Maine. Its base office in Stimson Hall provides academic and career advising for students interested in the marine sciences and administers the SEA Semester program for Cornell students pursuing studies at Woods Hole or aboard the schooner *Robert C. Seamans* or brigantine *Corwith Cramer*.

DISTRIBUTION REQUIREMENT

In the College of Agriculture and Life Sciences, the biological sciences distribution requirement (Group B) is a minimum of 9 credits, including at least 6 credits of introductory biology satisfied by Biological Sciences 109–110, 105–106, or 101 and 103 plus 102 and 104, or 107–108. Advanced placement in biology with a score of 4 or 5 (6 or 8 credits, respectively) satisfies the requirement for introductory biology. The additional credits may be satisfied by any biological sciences courses *except BIO G 200* (unless permission is obtained), *BIO G 209, or BIOSM 204*.

For students in the College of Arts and Sciences, all biology ("BIO") courses can be used toward fulfillment of the biological distribution requirement except *BIO G 200* (unless permission is obtained), *BIO G 209, or BIOSM 204*. The following courses are especially suitable for the distribution requirement because they have no prerequisites: BIO G 101–104, 105–106, 107–108, 109–110, 170, 202; BIOAP 212; BIOEE 154, 207, 275; BIOGD 184; BIOMI 192; BIONB 111; BIOPL 240, 241. Advanced placement in biology with a score of 4 or 5 (6 or 8 credits, respectively) may be applied to the Group 1 distribution area in accordance with regulations stipulated by the Arts College.

In the College of Human Ecology, the natural sciences distribution requirement is for at least 6 credits selected from BIO G 109–110, 101 and 103 plus 102 and 104, 105–106 or 107–108 or from specified courses in chemistry or physics. Advanced placement in biology with a score of 4 or 5 (6 or 8 credits, respectively) also satisfies the distribution requirement in the natural sciences.

Switching from one introductory biology sequence to another at midyear may not be possible because of variation in presentation of topics. Students must receive permission of the instructor to switch sequences. Taking sequences in reverse order is strongly discouraged.

USE OF ANIMALS IN THE BIOLOGICAL SCIENCES CURRICULUM: CORNELL UNIVERSITY

Students wishing to enroll in biology ("BIO") courses should know and understand the following criteria relative to the use of animals in the teaching program, as passed by the faculty of the Division of Biological Sciences in 1988, and reaffirmed in 1997:

1. "Live animals will be used for teaching in certain courses in the biological sciences. Some animals will require humane euthanasia after they have been used for teaching.
2. Courses bearing the "BIO" description conform to the rules for the care of such animals as outlined in Guiding Principles in the Care and Use of Animals (as approved by the Council of the American Physiological Society), the Guide for the Care and Use of Laboratory Animals. (DHEW publication 86–23, revised 1996; see p. 14, *Courses of Study*), the Animal Welfare Act, and the New York State Public Health Law. Within these regulations, and in keeping with the principle of Academic Freedom of the Faculty, the use of animals to aid in teaching any biological sciences discipline is at the discretion of the professor in charge.
3. Each course, as well as research projects, in which animals are used receives a formal review annually by the Cornell University Institutional Animal Care and Use Committee (IACUC).
4. Any concerns regarding the use of live animals in teaching should be addressed first to the faculty member responsible for that course. He or she is required to be in compliance with all applicable regulations and guidelines. Alternatively, students may choose to address their concerns to the director of the Cornell Center for Research Animal Resources, Dr. Michele Bailey, at 253–3520. The director may initiate discussion with the faculty member responsible for a particular course without involving the student if he or she would prefer to remain anonymous.
5. Enrollees in those courses in the biological sciences in which animal use is a component may, at the professor's discretion, be asked to sign copies of this statement (USE OF ANIMALS...) at the first meeting of the course."

ADVANCED PLACEMENT

For information on credit for advanced placement in Biological Sciences, please see the section on Advanced Placement in the front of this publication.

THE MAJOR

The major of biological sciences is available to students enrolled in either the College of Agriculture and Life Sciences or the College of Arts and Sciences. The undergraduate program is coordinated for students in both colleges by the Office of Undergraduate Biology. By completion of the sophomore year, all students who intend to major in biological sciences must declare the major and a program of study through the Office of Undergraduate Biology, in 216 Stimson Hall.

Whenever possible, students should include the introductory biology, chemistry, and mathematics sequences in their freshman schedule and complete the organic chemistry lecture course in their sophomore year. Biology majors should regularly monitor their progress in the major, and should assess as realistically as possible the likelihood of achieving at a level that is consistent with their academic and personal goals. Weak performance in core courses, particularly after the freshman year, may indicate a need to re-evaluate aptitude and genuine interest in the major. Students with questions, particularly with concerns about their ability to complete the major, are encouraged to consult with their biology adviser, and to take advantage of the advising and counseling resources of the Office of Undergraduate Biology as well as those of the university and their college.

The requirements for the biological sciences major are listed below. Requirements 1–9 must be taken for a letter grade. Courses taken for the program of study should be taken for a letter grade unless the course is

offered for S-U only or if the student's adviser grants permission.

1) **Introductory biology for majors** (one year): BIO G 101 and 103 plus 102 and 104, or 105–106. BIO G 107–108, offered during the eight-week Cornell Summer Session for eight credits, also satisfies the introductory biology requirement for majors. Students may choose to accept advanced placement credit if they have received a score of 5 on the Advanced Placement Examination of the College Entrance Examination Board (CEEB). Students with a score of 4 must fulfill the introductory biology requirement by taking BIO G 101–102, 101 and 103, 102 and 104, 103–104, or 105 or 106. These students should consult information available in the respective course offices and in the Office of Undergraduate Biology (216 Stimson Hall) to determine which semester to complete the introductory biology requirement. For students in doubt, completion of BIO G 101 and 103 or BIO G 105 is advised. These students receive a total of eight introductory biology credits (four AP credits plus four course credits).

2) **General chemistry** (one year): Chemistry 207–208,* or 206–208, or 215–216.*

3) **College mathematics** (one year): one semester of calculus (Mathematics 106, 111, 191 or their equivalent) plus one semester selected from the following:

   a. a second semester of calculus (Mathematics 112, 192, or their equivalents).

   b. a course in finite mathematics (Biometry 101, 417, Mathematics 105, 231).

   c. a course in statistics (Biometry 301, Mathematics 171, Applied Economics and Management 210, Psychology 350, Industrial and Labor Relations 210).

4) **Organic chemistry**: Chemistry 257 and 251, or 357–358 and 251, or 357–358 and 301, or 359–360 and 251, or 359–360 and 301.

5) **Physics:** Physics 207–208,* 112–213,* or 101–102. Those who take Physics 112–213 are advised to complete Physics 214 as well.

6) **Genetics:** BIOGD 281.

7) **Biochemistry:** BIOBM 330, or 331 and 332, or 333.

8) **Evolutionary Biology:** BIOEE 278 or BIOPL 448. Note: BIOPL 241, Botany, is a prerequisite course to BIOPL 448.

9) **A program of study** selected from the outline below.

10) **Foreign language:** students registered in the College of Agriculture and Life Sciences must satisfy the foreign language requirement for the biology major by (a) presenting evidence of successful completion of three or more years of study of a foreign language in high school or (b) achieving "qualification" status in a language as defined by the College of Arts and Sciences or (c) successfully completing at least six college credits in a foreign language. Students registered in the College of Arts and Sciences must satisfy the language requirement as stated by that college.

*Since modern biology has an important physical and quantitative orientation, students are advised to undertake basic science courses that emphasize this approach. Asterisks in the above list indicate the courses that provide this orientation, but all courses listed are acceptable.

Although not required for the biological sciences major, a course in statistics is recommended for students planning graduate study or a research career. Students should consult their faculty advisers when choosing appropriate courses in statistics.

Note: Core courses cannot count toward the Program of Study Requirements.

Programs of Study and Requirements

As noted in the list of requirements above, students accepted into the biological sciences major must choose a Program of Study. Whereas the core requirements of the biology curriculum provide the common foundation deemed essential for all biology majors, the role of the Program of Study is to provide either a concentration in a particular area of biology or, in the case of the General Biology Program of Study, a survey of biology that is broad but not superficial. The Program of Study requirement can be met by taking 13 to 15 credit hours of courses chosen by the student in consultation with his or her biology adviser. Programs of Study for particular subject areas are designed by faculty specializing in the subject. Typically, the Program of Study consists of one or more courses that provide foundation in the subject and a list of optional courses from that area or related areas, many of which are at an advanced level (300 or higher). Because biology is an experimental science, most Programs of Study require one or more laboratory courses. The laboratory requirement in some Programs of Study can be met by participation in the independent research course (BIO G 499). The possible Programs of Study and their requirements are listed below:

1) *Animal Physiology:* BIOAP 311 Introductory Animal Physiology, BIOAP 316 Cellular Physiology, plus a minimum of 7 credit hours selected from the following lecture and laboratory courses, of which at least 4 credit hours must be a laboratory course.

   a) Lecture courses: BEE 454 Physiological Engineering; AN SC 300 Animal Reproduction and Development; AN SC 410 Nutritional Physiology and Metabolism; AN SC 427 Fundamentals of Endocrinology; BIO G 305 Basic Immunology; BIOAP 214 Biological Basis of Sex Differences; BIOAP 458 Mammalian Physiology; BIOBM 407 Nature of Sensing and Response: Signal Transduction in Biological Systems; BIOBM 437 Eukaryotic Cell Proliferation; BIOGD 385 Developmental Biology; BIOGD 483 Molecular Aspects of Development; BIONB 322 Hormones and Behavior; BIONB 325 Neurodiseases-Molecular Aspects; BIONB 326 The Visual System; BIONB 492 Sensory Function; NS 331 Physiological and Biochemical Bases of Human Nutrition.

   b) Laboratory courses: BEE 454 AN SC 301 Animal Reproduction and Development; BIO G 401 Introduction to Scanning Microscopy; BIO G 403 Transmission Electron Microscopy for Biologists; BIOAP 413 Histology: The Biology of the Tissues; BIOAP 319 Animal Physiology Laboratory; BIOBM 440 Experimental Molecular Biology; BIOBM 441 Experimental Proteins and Enzymology; BIOBM 442 Experimental Cell Biology; BIOBM 443 Experimental Molecular Neurobiology; BIONB 491 Principles of Neurophysiology.

2) *Biochemistry:* Chemistry 300, Quantitative Chemistry; six credits of organic chemistry (Chemistry 357–358 or 359–360); a minimum of four credits of organic chemistry laboratory (Chemistry 301–302 or 301 or 251–252); four credits of biochemistry laboratory courses (BIOBM 440-442); and Physical Chemistry (Chemistry 389–390 or 287–288 or 389–288).

Note: Chemistry 288 is designed for biologists. Five hours of Biochemistry are recommended (331 and 332 or 330 and 334 or 333 and 334) and students interested in graduate work in biochemistry should take Physics 207–208 and consider taking a third semester of calculus in preparation for CHEM 389–390. Be sure to complete CHEM 207–208 or 215–216 during the freshman year.

Note: Biology majors in the College of Agriculture and Life Sciences who select this program of study are allowed to take up to 61 credit hours in the endowed colleges due to the high number of required endowed courses for this program of study.

3) *Computational Biology:* One course in computer programming (COM S 100, Introduction to Computer Programming or BEE 151, Introduction to Computing); one course in mathematics (MATH 221, Linear Algebra and Calculus; MATH 231, Linear Algebra; MATH 294, Engineering Mathematics II; MATH 420, Differential Equations and Dynamical Systems; BTRY 408, Theory of Probability; or BTRY 421, Matrix Computation); a bridging course, i.e., a course in mathematical modeling applied to biology (BIOEE 362, Dynamic Models in Biology, BIOEE 460, Theoretical Ecology; or BIOBM 321, Numerical Methods in Computational Molecular Biology); and one course from the following list of advanced courses:

   BIOBM 631, Protein Structure and Function; BIOGD 481, Population Genetics; BIOGD 484, Molecular Evolution; BIONB 330, Introduction to Computational Neuroscience; BIONB 422, Modeling Behavioral Evolution; BIOPL 440, Phylogenetic Systematics; AN SC 420, Quantitative Animal Genetics; NTRES 305, Wildlife Ecology; NTRES 340, Quantitative Population Analysis; NTRES 410, Quantitative Methods in Wildlife Management; NTRES 670, Spatial Statistics; BTRY 451,

Mathematical Modeling of Populations; BTRY 662, Mathematical Ecology; BTRY 408, Theory of Probability; MATH 420, Differential Equations and Dynamical Systems; COM S 211, Computers and Programming; COM S 409, Data Structures and Algorithms for Computational Science; OR&IE 360, Engineering Probability and Statistics II; OR&IE 361, Introductory Engineering Stochastic Processes.

Note: MATH 112, calculus should be used to fulfill the core requirement for a second term of math.

Note: Bridging courses require linear algebra (MATH 221, Linear Algebra and Calculus; or MATH 231, Linear Algebra; or MATH 294, Engineering Mathematics II; or BTRY 421, Matrix Computation). For bridging course BIOEE 460 Theoretical Ecology, MATH 420 Differential Equations and Dynamical Systems will also serve as a prerequisite.

Note: BTRY 408 and MATH 420 can satisfy either the math requirement or a requirement for an additional course.

Note: Students who use BTRY 408 to fulfill the additional mathematics requirement should not use OR&IE 360, Engineering Probability and Statistics II to fulfill the requirement for an additional course.

Note: Biology majors in the College of Agriculture and Life Sciences who select this program of study are allowed to take up to 61 credit hours in the endowed colleges due to the high number of required endowed courses for this program of study.

4) *Ecology and Evolutionary Biology*: BIOEE 261, Ecology and the Environment, and 10 credits from the following lists, including at least one course from each group:

   (a) BIOEE 274, The Vertebrates: Structure, Function, and Evolution; BIOEE 373, Biology of Marine Invertebrates, or BIOSM 376, Marine Invertebrate Zoology; BIOEE 471, Mammalogy; BIOEE 472, Herpetology; BIOEE 475, Ornithology; BIOEE 476, Biology of Fishes; BIOMI 415, Bacterial Diversity; BIOPL 241, Introductory Botany; BIOSM 449, Seaweeds, Plankton and Seagrasses; ENTOM 212, Insect Biology.

   (b) BIOEE 263, Field Ecology; BIOEE 452, Herbivores and Plants: Chemical Ecology and Coevolution; BIOEE 455, Insect Ecology; BIOEE 456, Stream Ecology; BIOEE 457 and 459 Limnology: Ecology of Lakes, Lectures and Laboratory; BIOEE 460, Theoretical Ecology; BIOEE 462, Marine Ecology; BIOEE 463 and 465, Plant Ecology and Population Biology, Lectures and Laboratory; BIOEE 464, Macroevolution; BIOEE 466 and 468, Physiological Plant Ecology, Lectures and Laboratory; BIOEE 473, Ecology of Agricultural Systems; BIOEE 478, Ecosystem Biology; BIOEE 479 (EAS 479), Paleobiology; BIOGD 481, Population Genetics; BIOGD 484, Molecular Evolution; BIOPL 447, Molecular Systematics; BIOPL 448, Plant Evolution and the Fossil Record; BIOSM 413, Research in Marine Ecology.

Note: Students are encouraged to gain experience in some aspect of field biology through course work at a biological field station.

Note: Toward that end, students may apply up to 6 credits of courses taken at the Shoals Marine Laboratory (including the courses listed above, and/or 4 credits of BIOSM 364) toward the 10 credits. The Ecology and Evolutionary Biology Program of study offers a specialization in Marine Biology and Oceanography (for a description, see section entitled COURSES IN MARINE SCIENCE).

Note: Alternatively, the Organization for Tropical Studies (OTS) offers an Undergraduate Semester Abroad Program, featuring two courses in biology (Fundamentals of Tropical Biology and Field Research in Tropical Biology). Students may substitute credit earned for these two courses for two 3-credit courses at the 400 level from list b. Information about the OTS Program is available at Cornell Abroad, 474 Uris Hall.

5) *General Biology:* The Program of Study in General Biology requires a minimum of 13 credit hours in addition to courses counted toward requirements 1–8 on page 153. These 13 credits must include:

   a) One course from each of three different programs of study in biology. Only those courses specifically listed as fulfilling a program of study requirement are acceptable without permission of adviser.

   b) A course with a laboratory.

   c) And, a minimum of two upper-level (300 and above) courses of two or more credits each.

100-level courses are not acceptable for meeting any of these requirements.
BIO G 498 may not be used to fulfill the requirements of this program of study. BIO G 499 (minimum of two credits, but no more than three credits) may count as one of the upper-level courses, and may count as the laboratory course with approval of the adviser, but it cannot count as a course representing a program of study.

Note: It is possible to use a single course to fulfill more than one requirement. For example, BIOAP 413, Histology, could count in all three areas: as a course in the Animal Physiology program of study, as an upper level course, and as a course with a lab.

6) *Genetics and Development:* A minimum of 13 credits, usually chosen from the following courses: BIOGD 385, Developmental Biology; BIOGD 387, Developmental Aspects of Evolution; BIOGD 389, Embryology; BIOGD 450, Vertebrate Development; BIOGD 480, Seminar in Developmental Biology; BIOGD 481, Population Genetics; BIOGD 482, Human Genetics and Society; BIOGD 483, Advanced Develpmental Biology; BIOGD 484, Molecular Evolution; BIOGD 486, Advanced Eukaryotic Genetics; BIOMI 485, Bacterial Genetics; BIONB 493, Developmental Neurobiology; BIOPL 343, Molecular Biology and Genetic Engineering of Plants; BIOGD 600, Development of Sensory Systems.

   Students may also choose from the following courses to complete the 13-credit requirement: BIOGD 682, Fertilization and Early Development; BIOGD 684, Advanced Topics in Population Genetics; BIOGD 687, Developmental Genetics; BIOBM 633, Biosynthesis of Macromolecules; BIOBM 639, The Nucleus; BIOMI 694, Genetics of Diverse Bacteria; BIOPL 641, Laboratory in Plant Molecular Biology; BIOPL 644, Plant Growth and Development; BIOPL 652, Plant Molecular Biology II; BIOPL 653, Plant Molecular Biology I; PL BR 606, Advanced Plant Genetics.

   Up to three credits for this program of study may be chosen from other biological sciences courses, including BIO G 499, Undergraduate Research in Biology, with approval of the faculty adviser.

7) *Insect Biology:* ENTOM 212, Insect Biology, plus a minimum of three additional courses totaling at least nine credits selected from the following two groups. At least one of the three additional courses must be selected from group (a).

   (a) ENTOM 322, Insect Morphology; ENTOM 331, Introductory Insect Systematics; ENTOM 483, Insect Physiology.

   (b) ENTOM 215, Spider Biology; ENTOM 325, Insect Behavior; ENTOM 352, Medical and Veterinary Entomology; ENTOM 370, Pesticides, the environment and Human Health; ENTOM 394, Circadian Rhythms; ENTOM 400, Insect Development; ENTOM 443, Entomology and Pathology of Trees and Shrubs; ENTOM 444, Integrated Pest Management; ENTOM 452, Herbivores and Plants; ENTOM 453, Historical Biogeography; ENTOM 455, Insect Ecology; ENTOM 456, Stream Ecology; ENTOM 463, Invertebrate Pathology; ENTOM 470, Ecological Genetics; ENTOM 471, Freshwater Invertebrate Biology and Biomonitoring; ENTOM 477, Biological Control; ENTOM 490, Insect Toxicology; ENTOM 644, Advanced IPM.

8) *Microbiology*: At least 13 credits including: BIOMI 290, General Microbiology, Lectures; BIOMI 291, General Microbiology, Laboratory; either BIOMI 414, Bacterial Diversity or BIOMI 416, Bacterial Physiology, and at least 2 courses from the following list: BIOMI 391, Advanced Microbiology Laboratory; BIOMI 418, Microbial Ecology; BIOMI 420, Microbial Genomics; or BIOMI 485, Bacterial Genetics.

9) *Molecular and Cell Biology*: Chemistry 357–358 or 359–360; BIOBM 432, Survey of Cell Biology; four credits of BIOBM 440–442, Laboratories in Molecular Biology, Biochemistry, and Cell Biology, and at least seven additional credits of courses that have a cell biological or molecular biological orientation. The seven additional hours should include at least two courses from the following list: BIOAP 619, Lipids; BIOBM 407, Nature of Sensing

and Response: Signal Transduction in Biological Systems; BIOBM 434, Applications of Molecular Biology; BIOBM 437, Eukaryotic Cell Proliferation; BIOBM 439, Molecular Basis of Human Disease; BIOBM 631, Protein Structure and Function; BIOBM 632, Membranes and Bioenergetics; BIOBM 633, Biosynthesis of Macromolecules; BIOBM 636, Advanced Cell Biology; BIOBM 639, The Nucleus; BIO G 305, Immunology; BIOGD 385, Developmental Biology; BIOGD 483, Advanced Developmental Biology; BIOGD 484, Molecular Evolution; BIOGD 486, Advanced Eukaryotic Genetics; BIOGD 682, Fertilization and the Early Embryo; BIOMI 290, General Microbiology, Lectures; BIOMI 408, Viruses and Disease I; BIOMI 409, Viruses and Disease II; BIOMI 485, Bacterial Genetics; BIOMI 420, Microbial Genomics; BIONB 222, Neurobiology and Behavior II: Introduction to Neurobiology; BIONB 325, Neurodiseases-Molecular Aspects; BIONB 425, Molecular Neurophysiology; BIONB 495, Molecular and Genetic Approaches to Neurosciences; BIOPL 343, Molecular Biology and Genetic Engineering of Plants; BIOPL 347, Laboratory in Molecular Biology and Genetic Engineering of Plants; BIOPL 444, Plant Cell Biology; BIOPL 641, Laboratory in Plant Molecular Biology; BIOPL 652, Plant Molecular Biology II. Five hours of biochemistry are recommended (BIOBM 331 and 332, or 330 and 334). CHEM 207–208 or 215-216 should be completed during the freshman year.

10) *Neurobiology and Behavior:* The two-semester introductory course sequence, Neurobiology and Behavior I and II (BIONB 221 and 222) with discussion section (four-credits per term), and seven additional credits. These additional credits must include a course from the neurobiology and behavior offerings (this course can NOT be BIONB 420, 720, or BIOG 499). However, BIONB 420, 720 and BIO G 499 MAY be used to supplement this neurobiology and behavior course to fulfill the seven additional credits. Students must consult their adviser for courses that may be applied toward the seven additional credits that are not listed in the Biological Sciences course offerings. BIO G 498 may not be used to fulfill the requirements of this program of study.

Note: Students who declare the Program of Study in Neurobiology and Behavior after taking BIONB 221 or 222 for only three credits must still take the 1 credit discussion section in BIONB 221 and 222. To arrange this, the student should consult the professors in charge of the two courses. In the event that a student cannot take the discussion sections, he or she should contact the department Director of Undergraduate Studies to determine what course(s) to use to address the deficiency.

11) *Nutrition:* NS 331, Physiological and Biochemical Bases of Human Nutrition (4 credits) and at least nine credits of additional coursework in the biological aspects of nutrition, such as NS 315, Obesity and the Regulation of Body Weight; NS 332, Methods in Nutritional Sciences; NS 347, Human Growth and Development NS 431, Mineral Nutrition and Chronic Disease; NS 441, Nutrition and Disease; NS 455, Nobel Prizes in Biomedical Research; NS 475, Molecular Nutrition and Development; NS 602, Lipids; NS 604, The Vitamins; and NS 614, Topics in Maternal and Child Nutrition. Some courses require NS 115 Nutrition and Health: Concepts and Controversies, which may be used as part of the additional nine credits.

Note: For students in the College of Agriculture and Life Sciences, credits in NS courses count towards the required 55 CALS credits. For students in the College of Arts and Sciences, NS credits will count toward the 100 hours required in A&S if those credits fulfill major requirements.

12) *Plant Biology:* Students choose one area of study from the following two options:

Option (a) *Botany:* Students are required to take Introductory Botany (BIOPL 241). Students should then choose, with the aid of their faculty adviser, a minimum of three of the following courses, for a total of at least 10 additional credits, to round out their botanical training: BIOPL 242 and 244, Plant Function and Growth, Lectures and Laboratory; BIOPL 243, Taxonomy of Cultivated Plants; BIOPL 247, Ethnobiology; BIOPL 248, Taxonomy of Vascular Plants; BIOPL 342 and 344, Plant Physiology, Lectures and Laboratory; BIOPL 343 and 347, Molecular Biology and Genetic Engineering of Plants, Lectures and Laboratory; BIOPL 345, Plant Anatomy; BIOPL 444, Plant Cell Biology; BIOPL 445, Photosynthesis; BIOPL 447, Molecular Systematics; BIOPL 448, Plant Evolution and the Fossil Record; BIOEE 463 and 465, Plant Ecology and Population Biology, Lectures and Laboratory; or BIOEE 466 and 468, Physiological Plant Ecology, Lectures and Laboratory.

Option (b) *Plant Biotechnology:* Students are required to take BIOPL 343 and 347, Molecular Biology and Genetic Engineering of Plants, Lectures and Laboratory. Students choose, in consultation with their faculty adviser, a minimum of 10 additional credits from the following list: BIOPL 241, Introductory Botany; BIOPL 242 and 244, Plant Function and Growth, Lectures and Laboratory; BIOPL 342 and 344, Plant Physiology, Lectures and Laboratory; BIOPL 444, Plant Cell Biology; BIOPL 648, Plant Biochemistry; PL BR 401, Plant Cell and Tissue Culture; or PL BR 402, Plant Tissue Culture Laboratory.

13) *Systematics and Biotic Diversity:* A minimum of 13 credits from the following two groups, including at least seven credits from group (a), and three from group (b), and at least two laboratory courses (marked with *). BIO G 499, Undergraduate Research in Biology, with approval of the adviser, can be used in fulfillment of up to four credits in group (a), and can count as one laboratory course if it has a laboratory component of two or more credits.

(a) *BIOEE 274, The Vertebrates: Structure, Function, and Evolution; *BIOEE 371, Human Paleontology; *BIOEE 373, The Invertebrates: Form, Function, and Evolution; *BIOEE 471, Mammalogy; *BIOEE 472, Herpetology; *BIOEE 475, Ornithology; *BIOEE 476, Biology of Fishes; BIOMI 290, General Microbiology, Lectures; *BIOMI 291, General Microbiology, Laboratory; BIOMI 415, Bacterial Diversity, Lectures; *BIOPL 241, Introductory Botany; *BIOPL 243, Taxonomy of Cultivated Plants; BIOPL 247, Ethnobiology; *BIOPL 248, Taxonomy of Vascular Plants; BIOPL 343, The Healing Forest; BIOPL 645, Families of Tropical Flowering Plants, Lectures; *BIOPL 646, Families of Tropical Flowering Plants; *ENTOM 212, Insect Biology; ENTOM 215, Spider Biology: Life on a Silken Thread; *ENTOM 322, Insect Morphology; *ENTOM 331, Introductory Insect Systematics; *ENTOM 471, Freshwater Invertebrate Biology; *ENTOM 631, Systematics of the Coleoptera; PL PA 309, Introductory Mycology; *PL PA 319, Field Mycology.

(b) BIOEE 464, Macroevolution; BIOEE 479, Paleobiology; *BIOPL 440, Phylogenetic Systematics; BIOPL 447, Molecular Systematics; *BIOPL 448, Plant Evolution and the Fossil Record; *BIOPL 453, Historical Biogeography; BIOPL 442, Current Topics in Ethnobiology.

14) *Independent Option:* Students who want to undertake a course of study not covered by the existing programs of study may petition the Biological Sciences Curriculum Committee. Information on independent option and Curriculum Committee petition forms are available in the Office of Undergraduate Biology, 216 Stimson Hall.

Independent Research and Honors Program

Biology majors are encouraged to consider participating in individual research under the direction of a Cornell faculty member. Students interested in participating in research should contact faculty members with compatible research interests. Faculty members may consider the students' previous academic accomplishments, interests and goals, and the availability of space and equipment when agreeing to supervise a student in his or her laboratory. Students conducting research may enroll for credit in Biological Sciences BIO G 499, Undergraduate Research in Biology. Registration for this course is done in 216 Stimson Hall. The student's research project must have significant biological content in order to be considered for BIO G 499 credit. Students may not earn credit for research conducted outside of Cornell. Up to three credits of research may be used to complete the program of studies in general biology, genetics and development, systematics and biotic diversity, as well as four

credits of research in neurobiology and behavior. Information about faculty research interests and undergraduate research opportunities is available in the Office of Undergraduate Biology, 216 Stimson Hall and at www.bio.cornell.edu.

The Honors program in biological sciences is designed to offer advanced training in laboratory or field research through the performance of an original research project under the direct guidance of a member of the Cornell faculty. Applications for the honors program are available in the Office of Undergraduate Biology, 216 Stimson Hall, and must be submitted in October of the senior year to the Honors Program Committee by the announced deadline. To qualify for the program, students must have been accepted into the biological sciences major, have completed at least 30 credits at Cornell, and have a cumulative grade-point average of at least 3.0. In addition, students must have at least a 3.0 cumulative grade-point average in all biology, chemistry, mathematics, and physics courses. (Grades earned in courses in other departments that are used to fulfill biology major requirements are included in this computation.) In addition, candidates must find a Cornell faculty member in Biological Sciences to supervise their research. An honors candidate usually enrolls for credit in BIO G 499, Undergraduate Research in Biology, under the direction of the faculty member acting as honors supervisor, although the Honors Program does not require enrollment for credit. Students accepted into the Honors program are required to participate in honors research seminars during both semesters of their senior year; submit an acceptable honors thesis; complete all major requirements; and maintain a 3.00 Cornell cumulative and science grade-point average through graduation. Recommendation to the faculty that a candidate graduate with honors and at what level of honors is the responsibility of the Honors Program Committee. The student's final grade point average is a factor in determining the level of honors recommended.

Students interested in the honors program are strongly encouraged to begin their research projects in their junior year and to consider spending the following summer here at Cornell engaged in full time research on their honors project. Students interested in staying for the summer also are encouraged to apply to the Cornell Hughes Scholars Program.

Biology majors who are considering study abroad and graduating with honors are encouraged to meet with their academic adviser during their sophomore year to carefully plan their academic schedule to meet the requirements of the Honors program.

Application forms, requirements, deadline dates for the Honors Program and the Hughes Scholars Program, and information pertaining to faculty research may be obtained at the Office of Undergraduate Biology, 216 Stimson Hall.

CURRICULUM COMMITTEE

Many decisions pertaining to the curriculum and to the programs of study are made by the Biology Curriculum Committee. The committee consists of faculty and elected student members and welcomes advice and suggestions from all interested parties.

ADVISING

Students in need of academic advice are encouraged to consult their advisers or come to the Office of Undergraduate Biology, 216 Stimson Hall.

Students interested in marine biology should visit the Shoals Marine Laboratory Office, G14 Stimson Hall.

Students interested in the multidisciplinary program of Biology and Society should see "Special Programs and Interdisciplinary Studies," in the College of Arts and Sciences section of this catalog.

INDEX OF COURSES

The following course identifiers are used to denote biological sciences courses in specific areas: General Courses, BIO G; Animal Physiology, BIOAP; Biochemistry, Molecular and Cell Biology, BIOBM; Ecology and Evolutionary Biology, BIOEE; Genetics and Development, BIOGD; Microbiology, BIOMI; Neurobiology and Behavior, BIONB; Plant Biology, BIOPL; Shoals Marine Laboratory, BIOSM.

Note: Biological sciences ("BIO") courses count as agriculture and life sciences credits for students in the College of Agriculture and Life Sciences and as arts and sciences credits for students in the College of Arts and Sciences.

Course Index

GENERAL COURSES (BIO G)

Three introductory biology course sequences are taught during the academic year: BIO G 101–104, BIO G 105–106, and BIO G 109–110; and one during the eight-week summer session: BIO G 107–108. BIO G 101–104, 105–106, and 107–108 are intended for biological sciences majors and other students needing eight credits from an introductory sequence for majors (for example, students in a premedical curriculum). Any of these sequences meet the prerequisite for upper-level courses listing "one year of introductory biology for majors" as a prerequisite. BIO G 109–110 is a course sequence intended for nonmajors, and meets the prerequisite for many, but not all, upper-level courses listing "one year of introductory biology" as a prerequisite. Students can earn a maximum of eight credits in introductory biology (including advanced placement credits).

BIO G 101–102 Biological Sciences, Lectures
101, fall; 102, spring. 2 credits each term. Prerequisite: concurrent enrollment in BIO G 103 (fall) or 104 (spring). Passing grade (D or better) in 101 is prerequisite to 102 unless permission is obtained from instructor. May not be taken for credit after BIO G 105–106 or 109–110. S-U grades optional, with permission of instructor. Lecs, M W F 9:05 or 10:10. 2 lecs each week; to accommodate these, students must reserve all 3 days. Evening prelims: fall, Sept. 26 and Nov. 5; spring, Feb. 20 and Apr. 1. T. G. Owens, C. Walcott.

Designed both for students who intend to specialize in biological sciences and for those who want to obtain a thorough knowledge of biology as part of their general education. The fall semester covers the chemical and cellular basis of life, energy transformations, physiology, neurobiology, and behavior. The spring semester covers genetics, development, evolution, and ecology. Each topic is considered in terms of modern evolutionary theory, and discussions of plant and animal systems are integrated. For those students who object to animal dissection, alternative materials are available for study. However, testing will involve identification of important structures in real organisms.

BIO G 103–104 Biological Sciences, Laboratory
103, fall; 104, spring. 2 credits each term. Prerequisite: concurrent enrollment in BIO G 101 (fall) or 102 (spring). 103 is prerequisite to 104 unless permission is obtained from instructor. No admittance after second week of classes. S-U grades optional, with permission of instructor. Lab, M T W or R 1:25–4:25, M or W 7:30–10:30 p.m., or T R or S 8–11. One 3-hour lab each week and a weekly lec for discs, special lecs, etc. J. C. Glase, P. R. Ecklund, and staff.

BIO G 103–104 is designed to provide laboratory experience with major biological phenomena in order to support an understanding of the important concepts, principles, and theories of modern biology. A second objective of the laboratory course is to help students gain expertise in the methods used by biologists to construct new knowledge. Students are exposed to basic concepts, research methods, including laboratory and data transformation techniques, and instrumentation in the major areas of biology. First-semester topics include biochemistry, physiology, plant biology, and behavior. In the second semester, laboratory experience is provided in the areas of genetics, biotechnology, invertebrate diversity, plant and animal development, and ecology. During the first semester, dissection of a doubly-pithed frog is included. Pithing is done by the instructor. Dissection of several invertebrates occurs during the second semester. For those students who object to animal dissection, alternative materials are available for study. However, testing will involve identification of important structures in real organisms.

BIO G 105–106 Introductory Biology
105, fall; 106, spring. 4 credits each term (or 2 credits, with permission of instructor). Enrollment limited to 200 students. Prerequisite: 105 is prerequisite to 106, unless written permission is obtained from instructor. May not be taken for credit after BIO G 101–104 or 109–110. No admittance after first week of classes. Lec, T 9:05 (first lec of fall term, R 8/29, 9:05); additional study and lab. Staff.

Designed primarily for biology majors, preprofessionals, and other students who desire a challenging, broad introduction to fundamental concepts of biology. Cell biology, physiology, anatomy (accompanied by preserved vertebrate dissection), and biochemistry are strongly emphasized in the fall semester. Subjects in the spring semester are genetics, development, ecology, evolution, behavior, and the diversity of organisms (accompanied by preserved and anesthetized invertebrate dissection). Students who plan to concentrate in anatomy and physiology should consider taking this course because of the strong emphasis on organismal biology. Because some testing involves the use of predissected specimens, students who object to dissections should take BIO G 101–104. The course uses an autotutorial format and offers considerable flexibility in scheduling. Completion of the course requires mastery of a group of core units. Testing on these units is primarily by oral examination. Students who elect to take the course must be able to meet deadlines. Four formal laboratory sessions are offered each semester; additional laboratory work is included in the core units. Evaluation is based on written reports on experimental work, practical exams, and a comprehensive final exam.

BIO G 107–108 General Biology
Summer (8-week session; 107, weeks 1–4; 108, weeks 5–8). 4 credits each. Prerequisite: one year of college or permission of instructor; BIO G 101, 103, 105, or 107 is a

prerequisite for 108. Fee, $25 for weeks 1–4; $15 for weeks 5–8. Lecs, M-R 9–12; labs, M T R 1:30–4:30, F 9–12. Staff.

Designed for students who plan further study in biology and for students who want a broad course in biology as part of their general education. BIO G 107 covers biological metabolism, first at the molecular level and then progressively to the organ system level. The laboratory work involves an introduction to some major techniques, vertebrate dissection, and a survey of plant organization. BIO G 108 seeks to integrate the topics of genetics, developmental biology, population biology, and ecology in a general consideration of biological evolution. The laboratory work is a continuation of the material covered in BIO G 107 and involves more techniques, a survey of animal organization, and the design and performance of a field study. BIO G 107–108 fulfills the introductory biology requirement for majors and forms a suitable introductory biology course sequence for students intending to go to medical school. For those students who object to animal dissection, alternative materials are available for study. However, testing will involve identification of important structures in real organisms.

BIO G 109–110 Biological Principles

109, fall; 110, spring. 3 credits each term. Limited to 600 students. Both BIO G 109 and 110, taken in either order, are required to fulfill the distribution requirement in the colleges of Agriculture and Life Sciences and Human Ecology. Either course fulfills the College of Arts and Sciences distribution requirement; however, both are recommended since they constitute a survey. Students with transfer credit must consult with the course instructors for appropriate course placement. Due to overlap in content, BIO G 109 may not be taken after BIO G 102 or BIO G 106, and BIO G 110 may not be taken after BIO G 101 or BIO G 105. BIO G 109–110 may not be used as an introductory course for the major in biological sciences or as introductory biology for premedical requirements. *Note that this course satisfies the prerequisite for many, but not all second- and third-level courses in biology.* Letter grade only. Students do not choose lab sections during course enrollment; lab assignments are made during the first day of classes. Evening prelims: fall, Sept. 26 and Nov. 5; spring, Feb. 20 and Apr. 3. Lecs, fall: T R 11:40, spring: M W F 9:05; lab meets alternate M T W R or F 2–4:25 or T 10:10–12:35 or W 7:30–10 p.m. H. Greene, D. Winkler, C. Eberhard and staff.

Students who do not plan to major in biology may take this broad introductory course. The content is designed to appeal to anyone who seeks a comprehensive knowledge of biology as part of a general education. Broad goals of the course encompass an understanding of the potential benefits and limitations of science, the complexity and workings of the natural world, and the internal machinery of life—how our bodies and those of other animals and plants work. Fall semester covers biological diversity, genetics, evolution, ecology, behavior and conservation biology; spring semester covers human physiology, plant development, genetic engineering, infectious diseases, and human health. Laboratory sections enable small groups of students to meet with course staff and are used for problem-solving experiments, demonstrations, and discussions. There are dissections of preserved vertebrate, invertebrate, and plant materials; for those students who object to dissection, alternative materials are available for study and there is no grade penalty for omitting dissection or observation of animals. Testing, for students choosing to be tested, will involve identification of important structures in real organisms.

BIO G 170 Evolution of the Earth and Life (also EAS 102)

Spring. 3 credits. S-U grades optional. Lecs, T R 9:05; lab, T W or R 2:00–4:25; field trips during lab. J. L. Cisne.

Course topics include: 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; and precedents for ongoing global change. The course also covers dinosaurs, mass extinctions, and human ancestry. Laboratories include work on reconstructing geological history and mapping ancient geography. Fossil-collecting on field trips.

BIO G 200 Special Studies in Biology

Fall, spring, or summer. 1–3 credits. Prerequisites: written permission from the Office of Undergraduate Biology. Students must register in 216 Stimson Hall. S-U grades optional, with permission of instructor. Hours TBA. Staff.

A registration device for students who want to take only a portion of a regular biological sciences course—for example, only the lectures or only the laboratory in a course that includes both. Only students who have already had training equivalent to the portion of the regular course that is to be omitted may register in this manner. This course may not be substituted for 100–level courses and may not be used in fulfillment of college distribution requirements except by permission from the Office of Undergraduate Biology

[BIO G 202 The Diversity of Life

Fall. 3 credits. S-U grades optional. Lecs, M W F 2:30. Not offered 2002–2003. J. I. Davis, J. J. Doyle.

The main focus of this course is on the diversity of living and extinct species. This diversity is examined from an evolutionary perspective, with attention to the principles employed in the discovery of species and in the analysis of relationships among them. Interactions between humans and other species are examined during the latter portion of the semester.]

BIO G 209 Introduction to Natural Science Illustration

Summer (6-week session). 2 credits. Limited to 12 students. Prerequisite: freehand drawing or permission of instructor. S-U grades optional. Lecs and labs, T R 6:30–9:30 p.m. B. S. King.

An introduction to the art of natural science illustration for publication, and to the techniques of various media including pencil, pen and ink, watercolor, colored pencil, scratchboard, and carbon dust. Potentials and limitations of line and half-tone reproduction, copyright, and portfolio presentation are discussed.

BIO G 305 Basic Immunology Lectures (also VETMI 315)

Fall. 3 credits. Strongly recommended: basic courses in microbiology, biochemistry, and genetics. S-U grades optional, with permission of instructor. Lecs, T R 8:30–9:55. J. A. Marsh.

A survey of immunology, with emphasis on the biological functions of the immune response.

BIO G 400 Undergraduate Seminar in Biology

Fall or spring. Variable credit (1–3 credits assigned for individual seminar offerings). May be repeated for credit. S-U grades optional. Staff.

From time to time specialized seminars on topics of interest to undergraduates are offered by visiting faculty or faculty from the departments of Ecology and Systematics, Genetics and Development, or Plant Biology. For students interested in Biochemistry, Physiology, or Neurobiology, please see descriptions under the appropriate section.

BIO G 401 Introduction to Scanning Electron Microscopy

Fall or spring, weeks 1–8. 1 credit. Limited to 8 students (fall), 12 students (spring). S-U grades optional. Fee may be charged. Lec, M 10:10; lab, T R or F 9:05–12:15 or T W or R 1:25–4:25. M. V. Parthasarathy.

An introductory course that includes the principle and use of the scanning electron microscope. Students use biological material to explore and understand some of the fine biological architecture. In addition to preparing the specimens, students use the scanning electron microscope to study and obtain micrographs of features that interest them.

BIO G 403 Transmission Electron Microscopy for Biologists

Fall. 1, 3, or 4 credits (4 credits if student takes both sections). Limited to 12 students. Prerequisites: BIOAP 313, BIOPL 345 or 443. S-U grades optional. Two sections: Sec 01, 1 credit, weeks 1–4; sec 02, 3 credits, weeks 5–12. Students may register for one or both sections. Fee may be charged. Lec, T 11:15; labs, M W or T R 1:25–4:25. M. V. Parthasarathy.

Section 01, 1 credit, weeks 1–4, covers the principles and use of the transmission electron microscopy (TEM), with emphasis on proper operation of the instrument and interpretation of images obtained. Negatively stained materials are used for viewing with the transmission electron microscope. Section 02, 3 credits, weeks 5–12, covers the principles and techniques of preparing biological material for transmission electron microscopy. Using animal, plant, and microbe materials this section studies chemical fixtures, cryofixations, ultrathin sectioning, immunogold localization, quantitative microscopy, and metal shadowing techniques. Students have two additional weeks to complete laboratory assignments at the end of each section.

BIO G 408 Presentation Skills for Biologists

Spring. 1 credit. Prerequisites: previous research experience. Preference given to students accepted into the Honors Program. L. Southard and G. Hess.

This course covers oral and written communication skills used in presenting research to other scientists. Topics covered include organization of scientific papers, presentation tips for research seminars, and preparation of visual aids using Power Point. All students present a 10-minute seminar on their research and evaluate other presentations.

BIO G 410 Teaching Contemporary Biology
Fall. 3 credits. Prerequisite: one year introductory biology; permission of instructor. L. Southard and S. Merkel.
This course provides students with the opportunity to experience teaching high school science. Students concentrate on a topic of current public interest, then develop teaching plans appropriate for high school students. The first part of the course consists of lectures, discussion, and laboratory experiments, which familiarize the students with the scientific content of the course. Students then work in teams with high school teachers to develop their presentations. The final part of the course includes practice presentations and teaching at regional high schools.

BIO G 431 Frontiers in Biophysics
Fall. 1/2 credit. S-U grades only. Lec TBA. G. Feigenson and staff.
A day of lectures on Saturday, Sept. 14, 9:00–4:00, Racker Room, Biotechnology Bldg. giving an overview of current research in biophysics at Cornell by faculty from different departments across the university. Designed for undergraduates who are considering a career in biophysics and for graduate students who are interested in biophysics research opportunities at Cornell.

BIO G 450 Light and Video Microscopy for Biologists
Spring. 3 credits. Limited to 12 students. Prerequisites: one year of introductory biology and permission of instructor. Lecs, T R 1:25–2:30; lab, R 2:30–4:30. R. O. Wayne.
Theoretical and practical aspects of light microscopy, including brightfield, darkfield, phase-contrast, polarization, Hoffman-modulation contrast, interference, differential-interference contrast, and fluorescence microscopy, as well as video- and computer-based digital image enhancement, are studied. Students learn both qualitative and quantitative techniques to probe noninvasively the structure and function of living cells.

BIO G 498 Teaching Experience
Fall or spring. 1–4 credits. Enrollment limited. Prerequisites: previous enrollment in the course to be taught or equivalent. *Arts students may not count this course toward graduation. They may, however, upon petition one time only to their class dean, carry fewer than 12* ***other*** *credits and remain in good standing. This would affect Dean's List eligibility, but not eligibility for graduating with distinction.* S-U grades optional, with permission of instructor. Staff.
Designed to give qualified undergraduate students teaching experience through actual involvement in planning and assisting in biology courses. This experience may include supervised participation in a discussion group, assisting in a biology laboratory, assisting in field biology, or tutoring. Biological sciences courses currently offering such experience include BIO G 105–106; BIOAP 311, 313, 319; BIOBM 330, 331; BIOEE 274, 475; BIOGD 281; and BIOMI 291, 292.

BIO G 499 Undergraduate Research in Biology
Fall or spring. Variable credit. *Students in the College of Arts and Sciences may not register for more than 6 credits per term with one supervisor or 8 credits per term with more than one supervisor.* Prerequisite: written permission of staff member who supervises the work and assigns the grade. Students must register in the Office of Undergraduate Biology in 216 Stimson Hall. Each student must submit an independent study statement describing the proposed research project during course registration. Applications are available in the college offices and in 216 Stimson Hall. Any faculty member in Biological Sciences may act as a supervisor. Supervisors outside of Cornell are not acceptable. S-U grades optional. Staff.
Practice in planning, conducting, and reporting independent laboratory and library research programs. Up to three credits of research may be used to complete the Programs of Study in general biology, genetics and development, and systematics and biotic diversity, and four credits of research in neurobiology and behavior.

BIO G 663 Nanobiotechnology (also A&EP 663)
Spring. 3 credits. Letter grade only. C. Batt and H. Craighead.
For course description see A&EP 663.

[BIO G 705 Advanced Immunology Lectures (also VETMI 705)
Spring. 3 credits. Prerequisite: basic immunology or equivalent or permission of instructor. Offered alternate years. Next offered spring 2004. Lecs, T R 10:10–11:35. Coordinator: J. A. Marsh.
Coverage of molecular and cellular immunology at an advanced level.]

BIO G 706 Immunology of Infectious Diseases (also VETMI 719)
Spring. 2 credits. Prerequisite: BIO G 305 or permission of instructor. S-U grades optional, with permission of instructor. Lec, R 10:10–12:05. Offered odd alternate years. Coordinator: E. Denkers.
This graduate level course focuses on molecular and cellular mechanisms underlying immunity to infectious diseases caused by viral, bacterial, protozoan, and helminth pathogens. Topics include immune response initiation; antigen presentation pathways; Th1 and Th2 cytokines in protection and pathology; mechanisms of cytolysis; immune evasion strategies; vaccines. Lectures are based upon recent advances in the field and are accompanied by relevant readings from the current literature.

ANIMAL PHYSIOLOGY (BIOAP)

BIOAP 212 Human Physiology for Non-Biology Majors
Spring. 3 credits. May not be taken for credit after BIOAP 311. Limited to 130 students. This course may be used toward the science distribution requirement of the College of Arts and Sciences and the Group B distribution requirement of the College of Agriculture and Life Sciences. This course may not be used to fulfill the requirements of any program of study in the biological sciences major. Lecs, M W F 1:25; disc, M W or F 2:15. M. D. Baustian.
Introduction to the principles of physiology governing the function of the human body. Emphasis is placed on reproduction, pregnancy and development, and immunology and the defense of the organism against disease. Major organ systems are surveyed to illustrate how physiologists study the function of living systems, and how this knowledge has shaped the management of health and disease. The contribution of information based sciences of genetics, molecular biology, and the emerging biotechnologies to the study of human physiology is covered.

BIOAP 214 Biological Basis of Sex Differences (also B&SOC 214 and WOMNS 214)
Spring. 3 credits. Prerequisite: one year of introductory biology. S-U grades optional. Lecs, T R 1:25–2:40. Offered alternate years. Offered in 2003. J. E. Fortune.
The structural and functional differences between the sexes are examined. Emphasis is placed on mechanisms of mammalian reproduction; where possible, special attention is given to studies of humans. Current evidence on the effects of gender on nonreproductive aspects of life (behavior, mental, and physical capabilities) is discussed. The course is intended to provide students with a basic knowledge of reproductive endocrinology and with a basis for objective evaluation of sex differences in relation to contemporary life.

BIOAP 311 Introductory Animal Physiology, Lectures (also VETPH 346)
Fall. 3 credits. Prerequisites: one year of college biology, chemistry, and mathematics. Recommended: previous or concurrent course in physics. S-U grades optional, with permission of instructor. Evening prelims. Lecs, M W F 11:15. E. R. Loew.
A general course in animal physiology emphasizing principles of operation, regulation, and integration common to a broad range of living systems from the cellular to the organismal level. Structure/function relationships are stressed along with underlying physico-chemical mechanisms.

BIOAP 312 Farm Animal Behavior (also ANSC 305)
Spring. 2 credits. Prerequisites: one year of introductory biology, and introductory animal physiology (ANSC 100 and 150 or equivalent is sufficient or BIOAP 311); at least 1 animal production course or equivalent experience is recommended. S-U grades optional. Lecs, T R 11:15. E. A. Oltenacu, K. A. Houpt.
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.

BIOAP 316 Cellular Physiology
Spring. 3 credits. Prerequisite: concurrent or previous enrollment in BIOBM 330 or 331 and 332 or 333. Evening prelims. Lecs, M W F 11:15–12:05. A. Quaroni.
A comprehensive course covering the general characteristics of eucaryotic cells, the structure, composition and function of subcellular organelles, and the major signal transduction pathways regulating a variety of physiological cell activities. Among the main subjects covered are absorption and transport processes, mechanism of action of signaling molecules (hormones), the cell cycle and regulation of cell proliferation, cell-cell communication, extracellular matrix, the immune system, and carcinogenesis.

BIOAP 319 Animal Physiology Experimentation
Fall. 4 credits. Designed for upper-level undergraduate and graduate students studying in physiology, and other students interested in biomedically related professions. Graduate students in the field of Physiology and related fields without equivalent background are strongly encouraged to enroll. Each of 2 afternoon laboratory sections is limited to 40 students. Prerequisite: concurrent or previous enrollment in BIOAP 311 or permission of instructor. Lec, R 12:20; lab, M or W 12:20–5:00. E. R. Loew, N. A. Lorr and staff.
A series of student-conducted *in vitro* and *in vivo* experiments designed to illustrate basic physiological processes in animals, with emphasis on relevance to humans, and to introduce students to physiology research techniques, instrumentation, experimental design, and interpretation of results. Techniques include anesthesia, surgical procedures, dissection under anesthesia, and real-time computer recording and analysis of data. Experiments with living tissues and live animals examine properties of membranes, blood, muscle, and nerves; cardiovascular, respiratory, and renal function and their control; and endocrine regulation of renal, cardiovascular, and reproductive tissue activity. Experimental resources include frogs, rats, rabbits, and sheep which are not always euthanized after the laboratory exercises. Written reports of laboratory activities are required. Grading is based on evaluation of these reports, laboratory performance, weekly quizzes, and a mid-term and a final exam.

BIOAP 413 Histology: The Biology of the Tissues
Spring. 4 credits. Prerequisite: one year of introductory biology. Recommended: BIOBM 330 or 331, or their equivalents; and previous enrollment in BIOAP 311. S-U grades optional, with permission of instructor. Lecs, M W 1:25; labs, M W 2:30–4:25. S. Suarez, L. Mizer.
Provides students with a basis for understanding the microscopic, fine-structural, and functional organization of vertebrates (primarily mammals), as well as methods of analytic morphology at the cell and tissue levels. Dynamic interrelations of structure, composition, and function in cells and tissues are emphasized.

BIOAP 427 Fundamentals of Endocrinology (also AN SC 427)
Fall. 3 credits. Prerequisite: animal or human physiology or permission of instructor. Lecs, M W F 9:05. P. A. Johnson.
For description, see AN SC 427.

BIOAP 458 Mammalian Physiology
Spring. 3 credits. Enrollment limited. Graduate student auditors allowed. Prerequisite: BIOAP 311 or equivalent. Students not meeting this prerequisite must obtain written permission of instructor in T8 014 Vet Research Tower before the first class. Evening prelims. Lecs, M W F 10:10. K. W. Beyenbach.
The course offers an in-depth treatment of selected topics in mammalian and human physiology. Emphasis is on concepts and a working knowledge of physiology. Selected topics include: basic functional elements of biological systems; recurrent themes in physiology; design of multicellular animals; mammalian fluid compartments; homeostasis; membrane and epithelial transport; electrophysiology; cardiovascular physiology; gastrointestinal physiology; renal physiology; and acid/base physiology. The lectures incorporate clinical correlations whenever appropriate. Occasional guest lecturers talk about work and careers in basic research and/or clinical medicine. Recommended for biological sciences majors, pre-med and pre-vet students, and beginning graduate students in physiology, nutrition, and animal science.

BIOAP 475 Mechanisms Underlying Mammalian Developmental Defects (also NS 475)
Spring. 3 credits. Prerequisites: BIOBM 330, 331–332, or 333 (may be taken concurrently). M W 9:05; lab, R 2:00. D. Noden and P. Stover.
For description, see NS 475.

BIOAP 619 Lipids (also NS 602)
Fall. 2 credits. Lecs, T R 11:15. A. Bensadoun.
Advanced course on biochemical, metabolic, and nutritional aspects of lipids. Emphasis is placed on critical analysis of current topics in lipid methodology; lipid absorption; lipoprotein secretion, molecular structure, and catabolism; molecular biology, function and regulation of lipoprotein receptors; mechanism of hormonal regulation of lipolysis and fatty acid synthesis; and cholesterol metabolism and atherosclerosis.

BIOAP 710–718 Special Topics in Physiology
Fall or spring. 1 or 2 credits for each topic. May be repeated for credit. Enrollment in each topic may be limited. S-U grades optional, with permission of instructor. Lectures, laboratories, discussions, and seminars on specialized topics.

BIOAP 711 Readings in Applied Animal Behavior
Fall. 1 credit. Prerequisite: BIOAP 311 or equivalent. Offered alternate years. Next offered in 2002. Lec, 1 hour each week TBA. K. A. Houpt.

BIOAP 713 The Physiology of Ingestive Behavior: Food and Water Intake
Fall. 1 credit. Prerequisite: introductory biology. T. R. Houpt.
A series of 1 to 1.5 hour weekly sessions in which the physiological mechanisms of hunger and thirst, primarily in mammals, are considered by the group. There are a mix of background readings, individual reports, and general discussion.

BIOAP 714 Cardiac Electrophysiology
Fall. 1 credit. Offered alternate years. R. Gilmour.
Survey of cardiac potentials, passive membrane properties, ion channels, and cardiac arrhythmias. Emphasis is on nonlinear dynamic aspects of cardiac electrophysiology and cardiac arrhythmias.

BIOAP 715 Stress Physiology: To Be Discussed as Part of Animal Welfare
Fall. 1 credit. Prerequisite: BIOAP 311 or equivalent required. Offered alternate years. Next offered fall 2002. K. A. Houpt.
The emphasis is on physiological assessment of stress.

BIOAP 719 Graduate Research in Animal Physiology (also VETPH 628)
Fall or spring. Variable credit. Prerequisites: written permission of the section chair and of the staff member who supervises the work and assigns the grade. S-U grades optional. Hours TBA. Staff.
Similar to BIO G 499 but intended for graduate students who are working with faculty members on an individual basis.

BIOAP 720 Animal Physiology and Anatomy Seminar
Spring and fall. 1 credit each semester. Prerequisite: admission to the graduate Field of Physiology.
This seminar course is designed to provide graduate students in the Field of Physiology with training to become professional scientists. Students who participate are required to give a seminar on their research. Advice and feedback are provided. Throughout the semester and in one special session devoted to a particular topic, advice is provided on subjects such as preparation of manuscripts, seminars, and grant proposals.

[BIOAP 757 Current Concepts in Reproductive Biology
Fall. 3 credits. Limited to 20 students. Prerequisites: undergraduate degree in biology and a strong interest in reproductive biology. S-U grades optional. Lec/disc, T R 10:10–12:05. Offered alternate years. Next offered in 2003–2004. J. E. Fortune, W. R. Butler, and staff.
A team-taught survey course in reproductive physiology/endocrinology. Lectures by a number of reproductive biologists on various aspects of male reproductive function (endocrine regulation, testis function, spermatogenesis, and sperm physiology/function); female reproductive function (endocrinology, ovarian development and functions, oocyte physiology/function); fertilization and early embryo development; pregnancy; parturition; puberty; and reproductive technology. Student participation in the form of discussions and/or presentations.]

BIOAP 811 Advanced Physiological Methods I
Fall. 2 credits. Enrollment limited. Prerequisites: graduate student status or permission of course coordinator. S-U grades only. Lab TBA. Coordinator: J. Ray.
This is a course for graduate students in physiology and related disciplines. Experiments are carried out in the laboratories of faculty members in the Field of Physiology to acquaint graduate students with the latest techniques/methods in biomedical/physiological/genomic research. Three modules are offered each semester by arrangement with the course coordinator.

BIOAP 812 Advanced Physiological Methods II
Spring. 2 credits. Enrollment limited. Prerequisites: graduate student status or permission of course coordinator. S-U grades only. Lab TBA. Coordinator: J. Ray.
This is a course for graduate students in physiology and related disciplines. Experiments are carried out in the laboratories of faculty members in the Field of Physiology to acquaint graduate students with the latest techniques/methods in biomedical/physiological/genomic research. Three modules are offered each semester by arrangement with the course coordinator.

Related Courses in Other Departments

Adaptations of Marine Organisms (Biological Sciences [BIOSM] 413)

Advanced Work in Animal Parasitology (Veterinary Microbiology 737)

Animal Development (Veterinary Anatomy 507)

Animal Reproduction and Development (Animal Science 300)

Developmental Biology (Biological Sciences [BIOGD] 385)

Embryology (Biological Sciences [BIOGD] 389)

Fundamentals of Endocrinology (Animal Science 427)

Insect Morphology (Entomology 322)

Integration and Coordination of Energy Metabolism (Biological Sciences [BIOBM] 637 and Nutritional Sciences 636)

Neuroanatomy (Veterinary Anatomy 504)

Sensory Function (Biological Sciences [BIONB] 492)

Teaching Experience (Biological Sciences [BIO G] 498)

Undergraduate Research in Biology (Biological Sciences [BIO G] 499)

BIOCHEMISTRY, MOLECULAR AND CELL BIOLOGY (BIOBM)

BIOBM 132 Orientation Lectures in Molecular Biology and Genetics (also BIOGD 132)
Spring, weeks 1–3. No credit. Primarily for freshmen, sophomores, and transfer students. S-U grades only. Lec, S 10:10, for first three S of semester. Staff.
Discussions by six professors about their research and promising new areas for research in the future.

BIOBM 232 Milestones in Molecular Biology and Genetics
Spring. 3 credits. Limited to freshmen and sophomores. Prerequisites: advanced placement biology or college-level introductory biology. Letter grade. Lecs, M W 9:05; disc, F 9:05. J. M. Lopez.
Lectures cover seminal genetic, biochemical, and cell and molecular biological experiments that were recognized by Nobel prizes. Discussion focuses on current scientific consequences of these seminal findings, together with their societal and/or economic ramifications.

[BIOBM 233 Introduction to Biomolecular Structure (also CHEM 233)
Fall. 2 credits. Limited to 30 students. Prerequisites: CHEM 207–208 or equivalents. Lecs, T R 2:30-3:20. Next offered fall 2003. S. E. Ealick.
This course is intended for students with a basic understanding of chemistry who are considering a program of study in biochemistry. The interrelationship between the structure and function of biologically important molecules is explored. Emphasis is placed on understanding the way in which the three-dimensional arrangements of atoms determine the biological properties of both small molecules and macromolecules such as proteins and enzymes. The study of molecular structure is aided by interactive computer graphics for visualizing three-dimensional structures of molecules.]

BIOBM 321 Numerical Methods in Computational Molecular Biology (see COM S 321)
Fall. 3 credits. Prerequisites: at least 1 course in calculus, such as MATH 106, 111, or 191 and a course in linear algebra, such as MATH 221 or 294 or BTRY 417. No particular course in programming is required, but the student should have some familiarity with iteration, arrays, and procedures.
For course description see COM S 321.

BIOBM 330–332 Principles of Biochemistry
Introductory biochemistry is offered in three formats: individualized instruction (330) and lectures (331 and 332) during the academic year, and lectures (333) during the summer. *Individualized instruction is offered to a maximum of 250 students each semester. Lectures are given fall semester (331), spring semester (332), and summer (333).*

BIOBM 330 Principles of Biochemistry, Individualized Instruction
Fall or spring. 4 credits. Prerequisites: one year of introductory biology for majors and one year of general chemistry and CHEM 257 or 357–358 (CHEM 358 may be taken concurrently) or equivalent, or permission of instructor. Concurrent registration in BIOBM 334 is encouraged. May not be taken for credit after BIOBM 331, 332, or 333. S-U grade optional for graduate students only. Hours TBA. Evening prelims: fall, Oct. 3 and Nov. 5; spring, Feb. 20 and Apr. 1. J. E. Blankenship, P. C. Hinkle, and staff.
Fourteen units that cover protein structure and function, enzymes, basic metabolic pathways, DNA, RNA, protein synthesis, and an introduction to gene cloning. No formal lectures, autotutorial format.

BIOBM 331 Principles of Biochemistry: Proteins and Metabolism
Fall. 3 credits. Prerequisites: one year of introductory biology for majors, one year of general chemistry, and CHEM 257 or 357–358 (CHEM 257 or 357 should not be taken concurrently) or equivalent, or permission of instructor. May not be taken for credit after BIOBM 330 or 333. S-U grades with permission of instructor. Evening prelim: Oct. 24. Lecs, M W F 10:10. G. W. Feigenson.
The chemical reactions important to biology, and the enzymes that catalyze these reactions, are discussed in an integrated format. Topics include protein folding, enzyme catalysis, bioenergetics, and key reactions of synthesis and catabolism.

BIOBM 332 Principles of Biochemistry: Molecular Biology
Spring. 2 credits. Prerequisites: one year of introductory biology for majors and previous or concurrent registration in organic chemistry, or permission of instructor. May not be taken for credit after BIOBM 330 or 333. S-U grades optional, with permission of instructor. Lecs, T R 12:20. B. K. Tye.
A comprehensive course in molecular biology that covers the structure and properties of DNA, DNA replication and recombination, synthesis and processing of RNA and proteins, the regulation of gene expression, and the principles and uses of recombinant DNA technologies.

BIOBM 333 Principles of Biochemistry: Proteins, Metabolism, and Molecular Biology
Summer (6-week session). 4 credits. Prerequisites: one year of introductory biology for majors, one year general chemistry, and CHEM 257, or 357–358, or equivalents, or permission of the instructor. May not be taken for credit after BIOBM 330, 331, or 332. Lecs, M-F 10:00–11:15. S. Ely or H. T. Nivison.
Topics include the structure and function of proteins, enzyme catalysis, metabolism, and the replication and expression of genes.

BIOBM 334 Computer Graphics and Molecular Biology
Fall or spring. 1 credit. Prerequisite: concurrent registration in BIOBM 330. If space permits, students who have completed BIOBM 331 or 333 and have either taken or are concurrently taking, BIOBM 332 will be permitted to register during the first week of classes. Hours TBA. J. E. Blankenship, P. C. Hinkle, and staff.
Visualization of complex biomolecules using Silicon Graphics computers. Group presentations on current topics in molecular biology.

BIOBM 407 Nature of Sensing and Response: Signal Transduction in Biological Systems (also PLPA 407)
Spring. 3 credits. Prerequisite: BIOBM 330 or 333 or 331 and previous or concurrent registration in 332. Recommended: BIOGD 281. S-U grades optional. Lecs T R 10:10–11:25. T. P. Delaney.
The responses of organisms and cells to their surroundings are examined to illustrate how biological systems sense their biotic and abiotic environment and communicate sensing into appropriate responses. A wide variety of response systems are explored to identify their unique features and to illustrate how similar processes are utilized by widely divergent organisms. Examples are drawn from prokaryote, plant, and animal systems for environmental sensing, control of development, and responses during disease. Discussion also examines the role of genetics and biochemistry in understanding signal transduction pathways, as well as the way these systems are perturbed by mutation and disease.

BIOBM 432 Survey of Cell Biology
Spring. 3 credits. Prerequisite: BIOBM 330, 333, or 331, and previous or concurrent registration in 332, or equivalent.

Recommended: BIOGD 281. S-U grades optional for graduate students only. Lecs, M W 8:40–9:55. W. J. Brown, V. M. Vogt.
A survey of a wide array of topics focusing on the general properties of eucaryotic cells. The topics include methods used for studying cells, the structure and function of the major cellular organelles, and analyses of cellular processes such as mitosis, endocytosis, cell motility, secretion, cell-to-cell communication, gene expression, and oncogenesis. Some of the material is covered in greater depth in BIOBM 437; BIOGD 483; and BIOBM 632, 636, and 639.

BIOBM 434 Applications of Molecular Biology to Medicine, Agriculture, and Industry
Fall. 3 credits. Enrollment limited to 50 students. Prerequisites: BIOBM 330 or 333 or 331 and 332. Recommended: BIOGD 281. S-U grades optional. Lecs, M W F 11:15–12:05. J. M. Calvo, S. Ely.
Lecture topics include large scale sequencing of genomes, drug discovery based upon genomics, combinational approaches to chemical libraries, pharmacogenetics, antibiotics derived from innate immune system, DNA and edible vaccines, transgenic animals, engineering plants resistant to insects, and gene therapy. About one-fifth of the course is devoted to exploring factors that are required for commercializing ideas and to some social ramifications of biotechnology.

BIOBM 435–436 Undergraduate Biochemistry Seminar
435, fall; 436, spring. 1 credit each term. May be repeated for credit. Limited to upperclass students. Prerequistites: BIOBM 330, 333, or 331 and 332 or written permission of instructor. S-U grades only. Seminar time TBA. Organizational meeting first W of each semester. Fall: J. M. Calvo and S. Ely; spring: D. Wilson.
Selected papers from the literature on a given topic are evaluated critically during six or seven two-hour meetings.

BIOBM 437 Eukaryotic Cell Proliferation (also TOX 437)
Fall. Variable credits. Students may take lectures for 2 credits, or take both lectures and discussions for 3 credits. Enrollment for discussion section is limited to 20 students, with preference given to graduate students. Prerequisite: BIOG 101–102 or BIOG 105–106 and BIOBM 330 or BIOBM 331–332. Recommended: BIOGD 281 and BIOGM 432. S-U grades optional. Lecs, T R 12:20–1:10. Disc, TBA.
R.-H. Chen
The course covers a wide spectrum of issues related to cell proliferation in eukaryotes. Lectures include various aspects of the regulation of cell division cycle and signal transduction pathways, with additional topics on oncogenesis, cell aging, and cell death. The facts as well as concepts and logics behind findings are presented in the lectures. Research articles are analyzed and discussed in depth during discussion section.

[BIOBM 438 Seminar In Applied Molecular Biology
Fall. 2 credits. Enrollment limited to 20 students. Prerequisites: BIOBM 330 or 333 or 331, and 332. Recommended: BIOGD 281. S-U grades optional. Next offered fall 2003. Sem, R 12:20–2:15. J. Calvo, S. Ely.
A seminar course focusing on topics such as: drugs that extend the life of AIDS patients; applications of human embryonic stem cell technology; genetically engineering plants for resistance to insects; bringing erythropoeitin to market; mining genetic variation within isolated human populations; and benefits from stimulating and blocking angiogenesis. Groups of students explore the underlying science and also consider some business and/or social implications for these topics.]

BIOBM 439 Molecular Basis of Human Disease (also BIOGD 439)
Fall. 3 credits. Prerequisites: BIOBM 330 or BIOBM 331–332 and genetics (e.g., BIOGD 281) or permission from instructor. Recommended: cell biology (e.g., BIOBM 432 or BIOAP 316) and physiology (e.g., BIOAP 311 or BIOAP 458). S-U grades optional. Lecs, T R 10:10–11:25.
W. L. Kraus.
This course examines how changes in the normal expression, structure, and activity of gene products caused by genetic mutations, epigenetic phenomena and environmental agents lead to human diseases. The material focuses on how these changes lead to alterations in normal cellular processes, as well as the resulting physiological consequences. Topics are selected from hormone insensitivity syndromes, inborn errors of metabolism, gene fusions resulting in hybrid proteins, gene amplification, gene inactivation, disruption of signaling pathways, disruption of metabolic pathways, and the molecular actions of infectious agents and environmental toxins. Examples of diseases are selected to emphasize various aspects of genetics, molecular biology, cell biology, physiology, immunology, and endocrinology that have been presented in other courses. In addition, the methods used to identify the underlying biochemical and genetic basis of the diseases, as well as possible pharmaceutical and genetic therapies for treating the diseases, are presented. A portion of each class period will be devoted to discussion and practice questions.

BIOBM 440–443 Laboratories in Molecular Biology, Biochemistry, Cell Biology and Molecular Neurobiology
Laboratory instruction in these areas is organized as a set of 2 credit modules, each module is taught for half a semester during the academic year and some modules are taught during the summer. Students usually sign up for two courses for a total of 4 credits; limited space is available for students taking only one course for 2 credits. Which courses are offered in each semester depends on scheduling constraints and student preferences. **Enrollment limited**, with preference given to undergraduates having Biochemistry or Molecular and Cell Biology Programs of Study and to graduate students with a minor in the Field of Biochemistry, Molecular and Cell Biology. Prerequisites: BIOBM 330, or 333, or 331 and previous or concurrent enrollment in 332, or 332 and previous or concurrent enrollment in 331, **and** permission of instructor. **Form to apply for admission to this course is found on the web [http://132.236.135.25/signup.html]. Submit applications for fall semester courses beginning February 15, and for spring semester courses beginning September 15**. Confirmation of enrollment status will be sent by e-mail during the week preceding CoursEnroll. Fall and Spring: Labs, M W 12:20–4:25 (disc, F 11:15 or 1:25) or T 9:05–4:25 (disc, R 11:15) or R 9:05–4:25 (disc, T 1:25). Summer (3-week session): M-F 10–5:30.

BIOBM 440 Experimental Molecular Biology
2 credits. Hours TBA. S. Ely or H. T. Nivison.
Experiments may include cloning of DNA fragments, restriction mapping, DNA sequencing, Southern blotting, and PCR. The experiments emphasize quantitative aspects as well as experimental design.

BIOBM 441 Experimental Proteins and Enzymology
2 credits. Hours TBA. S. Ely or H. T. Nivison.
Experiments may include purification of enzymes by salt fractionation, ion exchange chromatography, affinity chromatography, determination of kinetic parameters for an enzyme, analysis of proteins by rate zonal sedimentation, SDS-polyacrylamide gel electrophoresis, and immunoblotting.

BIOBM 442 Experimental Cell Biology
Spring only. 2 credits. Hours TBA. Staff.
Experiments include culture of animal cells, purification and analysis of subcellular components, immunofluorescence and electron microscopy, and *in vitro* assays.

BIOBM 443 Experimental Molecular Neurobiology (also BIONB 430)
Spring. Next offered spring 2003. Hours TBA. D. Deitcher.
Experiments include PCR, cloning of DNA fragments, RNA purification, restriction digests, bacterial transformation, and DNA sequencing. Experiments emphasize how molecular techniques can be applied to studying neurobiological problems.

BIOBM 450 Lab Projects in Molecular Biology and Biochemistry
Spring. 3 credits. Enrollment limited to 10 students. Prerequisites: 4 credits from any of the following lab courses; BIOBM 440, 441, 442, or 443 plus permission of instructor. Letter grade only. Lab, R 1:25–4:25 plus at least 3 additional lab hours by individual arrangement with the instructor. Disc, F 2:30. S. Ely.
Students work individually on projects of their choice pertaining to a common theme. Skills developed include literature and database searching, project and experimental design, keeping a legal notebook, weekly communication of results, and an oral presentation. Experimental techniques may include site-directed mutagenesis, affinity purification, whole-genome expression systems, molecular evolution of a compound, and exploration of the human genome.

BIOBM 631 Protein Structure and Function
Fall. 3 credits. Prerequisites: BIOBM 330 or 333 or 331 and 332 and organic chemistry. Recommended: physical chemistry. S-U grades optional. Lecs, M W F 9:05.
L. Nicholson and J. Fu.
Presentations on the principles of protein structure and the nature of enzymatic catalysis. Specific topics include protein folding, stability, dynamics and evolution, folded conformations and structure prediction, ligand binding energetics, and the structural basis of catalysis.

[BIOBM 632 Membranes and Bioenergetics
Spring. 2 credits. Prerequisite: BIOBM 330 or 333 or 331 and 332 or equivalent. Lecs, T R 11:15. Offered alternate years. Not offered 2003. P. C. Hinkle.
Structure and dynamics of biological membranes, physical methods, model membranes, ionophores, ion-transport ATPases, mitochondrial and chloroplast electron transfer chains, and examples of transport from plants, animals, and bacteria. Emphasis given to structure of membrane proteins.]

BIOBM 633 Biosynthesis of Macromolecules
Fall. 2 credits. Prerequisite: BIOBM 330 or 333 or 331 and 332. Recommended: BIOGD 281. Lecs, T R 9:05. J. W. Roberts, D. B. Wilson.
Synthesis of DNA, RNA, and proteins, and regulation of gene expression.

BIOBM 636 Advanced Cell Biology
Spring. 2 credits. Prerequisites: BIOBM 330 or 333 or 331 and 332, and 432, or their equivalents. Lec, T R 9:05–9:55. A. P. Bretscher.
This course aims to provide an integrated view of eukaryotic cell organization as elucidated using biochemical molecular, genetic, and cell biological approaches. Major topics include the cytoskeleton, membrane traffic and, cell polarity. Together with BIOBM 437, 632, and 639 this course provides broad coverage of the cell biology subject area.

BIOBM 639 The Nucleus
Spring. 2 credits. Prerequisite: BIOBM 330 or 333 or 331 and 332, or their equivalent. Recommended: BIOGD 281. Lec, T R 10:10. J. T. Lis.
Lectures on topics of eucaryotic genome organization, chromatin structure, regulation of gene expression, RNA processing, the structure and movement of chromosomes, and nuclear export and import. This course covers the structure and function of the nucleus at the molecular and cell biological levels, and together with BIOBM 437, 632 and 636, provides broad coverage of the cell biology subject area.

BIOBM 641 Laboratory In Plant Molecular Biology (also BIOPL 641)
Fall. 4 credits. Prerequisites: BIOGD 281 or equivalent, BIOBM 330 or 331 or equivalent, and permission of instructor. S-U grades with permission of instructor. Lab, T 9:05–4:30. J. B. Nasrallah, M. R. Hanson.
Selected experiments on gene expression, gene transfer, and assay of reporter genes in plants. The course emphasizes the application of molecular biology methodology to plant systems. Additional lab time is required to complete assignments.

BIOBM 652 (Section 05) Molecular Biology of Plant Organelles (also BIOPL 652.5)
1 credit. Lecs, M W F 10:10 (12 lecs) Feb. 17–Mar. 14. M. R. Hanson, D. B. Stern.
An in-depth examination of the molecular biology of plant mitochondria and plastids. Topics include the organization, evolution, and expression of organelle genomes, RNA editing, and the expression of nuclear genes encoding structural or regulatory organelle proteins. Special topics include mitochondrially-encoded cytoplasmic male sterility, transformation and expression of foreign genes in chloroplasts, and the use of genetics to investigate nucleus-organellar interactions.

BIOBM 653 (Section 04) Molecular Aspects of Plant Development I (also BIOPL 653.4)
1 credit. Lecs, M W F 10:10 (12 lecs) Nov. 1–Dec. 2. J. B. Nasrallah.
This module focuses on the molecular genetics of plant development. Current approaches to the elucidation of the molecular signals and pathways that lead to the establishment of the differentiated state of floral cells and organs are discussed. Topics include cell-cell signalling in the establishment of pattern and differentiation of specialized cell types, and the control of developmental pathways by endogenous and external cues. The module is a companion to BIOPL 652, Sec 02 (Molecular Aspects of Plant Development II).

BIOBM 730 Protein NMR Spectroscopy (also VETPR 730)
Spring. 2 credits. Prerequisites: CHEM 389 and 390 or CHEM 287 and 288 or permission of instructor. S-U grades optional. Offered every other year. Lec TBA. L. K. Nicholson, R. E. Oswald.
The student acquires the tools necessary for in-depth understanding of multidimensional, multinuclear NMR experiments. Schemes for magnetization transfer, selective excitation, water suppression, decoupling, and others are presented. The application of these techniques to proteins for resonance assignment, structure determination, and dynamics' characterization is studied.

BIOBM 732–737 Current Topics in Biochemistry
Fall or spring. 1/2 or 1 credit for each topic. May be repeated for credit. Prerequisite: BIOBM 330 or 333 or 331 and 332 or equivalent. S-U grades only. Hours TBA.
Lectures and seminars on specialized topics. Topics for fall and spring to be announced in the division's course supplement published at the beginning of each semester.

BIOBM 738 Macromolecular Crystallography (also CHEM 788)
Spring. 3 credits. S-U grades optional. Prerequisite: permission of instructor. Lecs, M W F 10:10. Offered alternate years. S. E. Ealick.
Lectures briefly cover the fundamentals of crystallography and focus on methods for determining the three-dimensional structures of macromolecules.

BIOBM 751 Ethical Issues and Professional Responsibilities
Spring. 1 credit. Limited to graduate students beyond first year. S-U grades only. Organizational meeting will be held on the first W of the semester. Sem, W 3:35–4:25. Additional sections may be offered. P. Hinkle.
Ethical issues in research and the professional responsibilities of scientists are discussed in a case-study format. Topics discussed include: regulations; data selection, manipulation, and representation; fraud, misconduct, and whistle-blowing; conflicts of interest and commitment; authorship, ownership, and intellectual properties; peer review and confidentiality; scientific response to external pressure; legal liabilities; and professional codes of ethics.

BIOBM 761 Topics in Cancer Cell Biology (also VETMM 761)
Spring. Series of 1 credit graduate sections that reflect the "cancer expertise" of the Cornell faculty. (Course Director: Dr. B. U. Pauli).
For description, see VETMM 761.

BIOBM 830 Biochemistry Seminar
Fall or spring. No credit. Sem, F 4:00. Staff.
Lectures on current research in biochemistry, presented by distinguished visitors and staff members. Lectures are open to everyone, but registration is limited to graduate students in Biochemistry, Molecular and Cell Biology.

BIOBM 831 Advanced Biochemical Methods I
Fall. 6 credits. Required of, and limited to, first year graduate students in the Field of Biochemistry, Molecular and Cell Biology. S-U grades only. Labs and discussions 12 hours each week TBA. Organizational meeting first R of semester 10:10. V. M. Vogt and T. Huffaker.
The first half of this course comprises an intensive laboratory covering fundamental aspects of modern molecular biology and cell biology. The second half of the course compromises research in the laboratory of a professor chosen by the student (See BIOBM 832). Students must enroll separately for each half.

BIOBM 832 Advanced Biochemical Methods II
Spring. 6 credits. Required of, and limited to, first year graduate students in the Field of Biochemistry, Molecular and Cell Biology. S-U grades only. Lab TBA. Staff.
Research in the laboratories of two different professors chosen by the student. Arrangements are made jointly between the Director of Graduate Studies and the research adviser.

BIOBM 833 Research Seminar in Biochemistry
Fall or spring. 1 credit each term. May be repeated for credit. Required of, and limited to, second-, third-, and fourth-year graduate students majoring in the field of biochemistry, molecular and cell biology. S-U grades only. Sem, M 12:20–1:30. T. C. Huffaker.
Each student presents one seminar per year on his or her thesis research and then meets with instructors and thesis committee members for evaluation.

BIOBM 836 Methods and Logic in Biochemistry, Molecular and Cell Biology, Part I
Spring. 1 credit. Limited to first-year graduate students majoring in the Field of Biochemistry, Molecular and Cell Biology. S-U grades only. Sem and disc TBA. G. P. Hess.
A seminar course with critical discussion by students of original research papers. A variety of topics in biochemistry, molecular and cell biology are covered.

BIOBM 838 Methods and Logic in Biochemistry, Molecular and Cell Biology, Part II
Spring. 2 credits. Limited to second year graduate students majoring in the Field of Biochemistry, Molecular and Cell Biology. S-U grades only. Monday, 9–11. D. Shalloway.
An interactive seminar to develop general skills needed to support a career in scientific research: experimental design, writing

scientific papers and grants, oral presentation, basic statistical and computational methods, managing a research laboratory, etc. Student projects include preparation and presentation of a mock research grant proposal.

Related Courses in Other Departments

Lipids (Biological Sciences [BIOAP] 619 and Nutritional Sciences 602)

Molecular Aspects of Development (Biological Sciences [BIOGD] 483)

Molecular Biology Techniques for Animal Biologists (Animal Science 650)

Molecular Mechanisms of Hormone Action (Biological Sciences [BIOAP] 658 and Veterinary Medicine 758)

Teaching Experience (Biological Sciences [BIO G] 498)

Undergraduate Research in Biology (Biological Sciences [BIO G] 499)

ECOLOGY AND EVOLUTIONARY BIOLOGY (BIOEE)

BIOEE 154 The Sea: An Introduction to Oceanography, Lectures (also EAS 154)

Spring. 3 credits. The optional one-credit laboratory for this course is offered as BIOEE/EAS 155. S-U grades optional. Lecs, T R 11:40–12:55. C. H. Greene, W. M. White.

A survey of the physics, chemistry, geology, and biology of the oceans for both science and non-science majors. Topics include: seafloor spreading and plate tectonics, marine sedimentation, chemistry of seawater, ocean currents and circulation, the oceans and climate change, ocean ecology, and coastal processes.

BIOEE 155 The Sea: An Introduction to Oceanography, Laboratory (also EAS 155)

Spring. 1 credit. Prerequisite: concurrent enrollment in BIOEE/EAS 154. S-U grades optional. Lab, M 2:00–4:25 or 7:30–9:55 p.m., or W 7:30–9:55 p.m. C. H. Greene, W. M. White.

Laboratory course covering topics presented in BIOEE/EAS 154.

BIOEE 207 Evolution (also HIST 287 and S&TS 287)

Fall or summer. 3 credits. Intended for students with no background in college biology. May not be taken for credit after BIOEE 278. Does not meet the evolutionary biology requirement for the biological sciences major. S-U grades optional. Fall: Lecs, T R 10:10; disc, 1 hour each week TBA. Summer (6-week session): Lecs and discs, M W 6:00–9:00 p.m. W. B. Provine.

Evolution is the central concept in biology. This course examines evolution in historical and cultural contexts. This course aims to understand the major issues in the history and current status of evolutionary biology, and explore the implications of evolution for culture. Issues range from controversies over mechanisms of evolution in natural populations to the conflict between creationists and evolutionists.

BIOEE 261 Ecology and the Environment

Fall or summer. 4 credits. Prerequisite: one year of introductory biology. S-U grades optional. Lecs, M W F 11:15; disc, W or R 1:25, 2:30, or 3:35. A. S. Flecker, J. P. Sparks.

We explore the interactions between the environment and organisms as individuals, populations, communities, and ecosystems. The emphasis is on basic ecological principles and processes that are generally useful in understanding the world around us and in more advanced studies in the environmental sciences, including management-oriented disciplines. Major topics include adaptive strategies of organisms, population dynamics, species interactions, community structure and function, biodiversity, biogeochemistry, and productivity. Human influences on ecosystems, human-created ecosystems (agricultural and urban ecosystems), and sustainable practices are covered.

BIOEE 263 Field Ecology

Fall. 3 credits. Limited to 25 students. Prerequisite: concurrent or previous enrollment in BIOEE 261. Lec, R 1:25; lab, F 12:20–4:25; 1 weekend field trip to the Hudson Valley. R. B. Root.

Field exercises designed to give students direct experience with field work, with emphasis on developing observational skills, journal keeping, and a landscape perspective. Topics include plant succession, niche relationships of insects, influence of herbivores and competition on plant performance, decomposition of soil litter, foraging behavior, census methods, and use of scientific collections.

[BIOEE 264 Birds in Biology

Fall. 3 credits. Limited to 25 students. May not be taken for credit after BIOEE 475. Intended primarily for biology nonmajors. S-U grades optional. Lecs and discs, T R 8:40–9:55; 2 field trips TBA. Offered alternate years. Not offered 2002–2003. A. A. Dhondt.

This course explores exciting new insights in biology using detailed examples drawn from bird studies. Subject matter is suitable for nonmajors, but of interest to majors as well. Topics are drawn from a variety of biological disciplines. These include behavioral ecology (mating systems, territorial behavior, song), population ecology (migration, population limitation, micro-evolution, competition), evolutionary biology (trade-offs in life histories, optimal clutch size), and conservation biology (habitat fragmentation, inbreeding, acid rain). Lectures are interspersed with discussion of selected papers.]

[BIOEE 267 Introduction to Conservation Biology

Fall. 3 credits. May not be taken for credit after NTRES 450. Intended for both science and non-science majors. Completion of BIOEE 267 is not required for NTRES 450. S-U grades optional. Lecs, M W 9:05; disc, F 9:05 or R 2:30; 1 Saturday field trip. Offered alternate years. Not offered 2002–2003; next offered fall 2003. A. S. Flecker, J. W. Fitzpatrick.

An exploration of biological concepts related to conserving the earth's biodiversity, introducing ecological and evolutionary principles important for understanding major conservation problems. Topics include patterns of species and ecosystem diversity, causes of extinction, genetic risks of small populations, design of nature preserves, strategies for protecting endangered species, ecosystem restoration, and the value of biodiversity.]

BIOEE 274 The Vertebrates: Structure, Function, and Evolution

Spring. 4 credits. Prerequisite: one year of introductory biology. Fee, $25. S-U grades optional. Lecs, M W F 9:05 ; lab, M T or W 1:25–4:25. K. R. Zamudio.

An introductory course in vertebrate organismal biology which explores the structure and function of vertebrates with an emphasis on trends in vertebrate evolution. Lectures cover topics such as the origin and evolution of various vertebrate groups, sensory systems, thermoregulation, life history, locomotion, feeding, size, and scaling. Laboratories include dissections of preserved vertebrate animals and noninvasive live animal demonstrations.

BIOEE 275 Human Biology and Evolution (also ANTHR 275 and NS 275)

Fall. 3 credits. S-U grades optional, with permission of either instructor. Lecs, M W F 10:10; disc, M 10:10 or TBA. Lecs every W and F; occasional lectures on M. Offered alternate years. K. A. R. Kennedy, J. D. Haas.

An introduction to the biology of *Homo sapiens* through an examination of human evolution, biological diversity, and modes of adaptation to past and present environments. Evolutionary theory is reviewed in relation to the current evidence from the fossil record and studies of the evolution of human behavior. A survey of human adaptation covers a complex of biological and behavioral responses to environmental stress. Human diversity is examined as the product of long-term evolutionary forces and short-term adaptive responses. Topics such as creationism, the Piltdown fraud, the sociobiology debate, genetic engineering, race and IQ, and racism are presented as examples of current issues in human biology.

BIOEE 278 Evolutionary Biology

Fall or spring. 3 or 4 credits. (4-credit option involves writing component and two discussion sections per week; limited to 20 students per section each semester. Students may not preregister for the 4-credit option; interested students complete an application form on the first day of class.) Limited to 300 students. Prerequisite: 1 year of introductory biology or permission of instructor. S-U grades optional. Evening prelims: fall, Sept. 26 and Oct. 31; spring, Feb. 27 and Apr. 1. Lecs, T R 9:05; disc, 1 hour each week TBA. Fall, I. Lovette; spring, M. Shulman.

The course considers explanations for patterns of diversity and for the apparent "good fit" of organisms to the environment. Topics covered include the genetic and developmental basis of evolutionary change, processes at the population level, the theory of evolution by natural selection, levels of selection, concepts of fitness and adaptation, modes of speciation, long-term trends in evolution, rates of evolution, and extinction. Students taking the four-credit option read additional materials from the primary literature and write a series of essays in plaçe of the regular prelims.

[BIOEE 362 Dynamic Models in Biology (also MATH 362)

Spring. 3 credits. Prerequisites: two semesters of introductory biology (BIO G 101–102, 105–106, 107–108, 109–110 or equivalent) and completion of the mathematics requirements for the Biological Sciences major or equivalent. S-U grades optional. Lecs, M W F 10:10–11:00. Some class meetings (during the regular lecture time) will be in computer lab. Offered alternate years. Not offered 2002–2003. S. P. Ellner, J. M. Guckenheimer.

Introductory survey of the development, computer implementation, and applications of dynamic models in biology and ecology. Case-study format, covering a broad range of current application areas such as regulatory networks, neurobiology, cardiology, infectious disease management, and conservation of endangered species. Students also learn how to construct and study biological systems models on the computer using a scripting and graphics environment.]

[BIOEE 371 Human Paleontology (also ANTHR 371)

Fall. 4 credits. Prerequisite: one year of introductory biology or ANTHR 101 or permission of instructor. Lecs, M W F 2:30; lab, 1 hour each week TBA; occasional field trips. Offered alternate years. Not offered 2002–2003. K. A. R. Kennedy.

A broad survey of the fossil evidence for human evolution with special attention to skeletal and dental anatomy, geological contexts, paleoecology, dating methods, archaeological associations, and current theories of human origins and physical diversity.]

[BIOEE 373 Biology of the Marine Invertebrates

Fall (but course must be taken in the previous summer at the Shoals Marine Laboratory [SML]). 5 credits. Limited to 24 students. Prerequisite: one year of introductory biology for majors. Permission of faculty required because it is off campus. Students in BIOEE 373 are strongly encouraged to take BIOEE 477. Three week, full time course. Daily and evening lectures, laboratories, and field work. Course is taken during the summer; enroll for credit during the subsequent fall semester. Total cost for room, board, and overhead at SML: $1,150. Offered alternate years. Not offered 2002–2003. C. D. Harvell, J. G. Morin.

An introduction to the biology and evolution of the major invertebrate phyla, concentrating on marine representatives. In addition to the evolution of form and function, lectures cover aspects of ecology, behavior, physiology, chemical ecology, and natural history of invertebrates. The Shoals Marine Laboratory exposes students to a wealth of marine and terrestrial invertebrates in their natural habitats. Regular field excursions allow an excellent opportunity to study freshly collected and *in situ* representatives of most of the major phyla.]

BIOEE 405 Biology of the Neotropics

Fall. 2 credits. Limited to 18 students. Prerequisite: BIOEE 261 or permission of instructor. S-U grades optional. Lec and disc, W 7:30–9:30 p.m. P. H. Wrege, A. S. Flecker.

This course is an introductory survey of the biology of the New World tropics, with primary focus on moist lowland forests. The objectives are to learn basic characteristics and phenomena important to understanding neotropical biology, to gain firsthand knowledge of the resources in tropical biology available at Cornell, and to learn how to organize and execute a meaningful seminar presentation.

BIOEE 452 Herbivores and Plants: Chemical Ecology and Coevolution (also ENTOM 452)

Spring. 3 credits. Prerequisites: one year of introductory biology, BIOEE 261, CHEM 257 or 357/358 and 251 or 301, or permission of instructor. S-U grades optional. Field trips, additional lectures, or laboratory demonstrations may be held in place of F lecture. Lecs, M W F 11:15. Offered alternate years. P. P. Feeny.

Topics include: significance of plant chemistry in mediating interactions between plants and herbivorous animals; mechanisms and strategies of plant finding and exploitation by animals, especially insects, and of defense and escape by plants; evolutionary hypotheses for ecological patterns of resistance and attack; and implications for human food and agriculture.

BIOEE 453 Speciation

Fall. 3 credits. Limited to 40 students. Prerequisites: BIOEE 278 and BIOGD 281 or equivalents, or permission of instructor. S-U grades optional. Lecs, T R 10:10–11:25. Offered alternate years. R. G. Harrison.

An advanced course in evolutionary biology focusing on the pattern and process of speciation and the nature and origin of intrinsic barriers to gene exchange. Topics covered in lectures include species concepts and definitions, the history of ideas about speciation, the biological basis of intrinsic barriers to gene exchange, current models for the origin of such barriers, genetic architecture of speciation, rates of speciation. Emphasis will be on developing a rigorous conceptual framework for discussing speciation and on detailed analysis of a series of case histories.

[BIOEE 455 Insect Ecology (also ENTOM 455)

Fall. 3 credits. Prerequisites: BIOEE 261 or equivalent and ENTOM 212 or knowledge of another taxon. S-U grades optional. Lecs, M W F 11:15. Offered alternate years. Not offered 2002–2003. R. B. Root.

Topics include the nature and consequences of biotic diversity, biogeography, coevolution, adaptive syndromes exhibited by various guilds, population regulation, impact of insects on ecosystems, comparative and functional analysis of communities, and differences in the organization of natural and managed systems. Ecological and evolutionary principles are integrated by thorough study of exemplars.]

[BIOEE 456 Stream Ecology (also ENTOM 456 and NTRES 456)

Spring. 4 credits. Limited to 60 students. Recommended: BIOEE 261. S-U grades optional. Field project with lab papers. Lecs, T R 9:05; lab, T W or R 1:25–4:25. Offered alternate years. Not offered 2002–2003. B. L. Peckarsky.

For description, see ENTOM 456.]

BIOEE 457 Limnology: Ecology of Lakes, Lectures

Fall. 3 credits. Prerequisite: BIOEE 261 or written permission of instructor. Recommended: introductory chemistry. Letter grade, S-U by permission only. Lecs, M W F 11:15. Offered alternate years. N. G. Hairston, Jr.

Limnology is the study of fresh waters and other inland, nonmarine environments. This course focuses on lakes and ponds, which are discussed as distinct aquatic environments with clear terrestrial boundaries, and within which ecological interactions are especially evident. In lakes, interactions between organisms are often strong and adaptations easily recognized. Physical and chemical properties of the environment impact organisms in important ways and organisms, likewise, influence physics and chemistry. As a result, lakes provide excellent systems for understanding the links between physical (thermal and mixing), chemical (dissolved elements and compounds), and organismal dynamics. Lakes are exciting environments for study in their own right, and for gaining perspective on ecological and evolutionary processes in general.

BIOEE 459 Limnology: Ecology of Lakes, Laboratory

Fall. 2 credits. Prerequisite: concurrent or previous enrollment in BIOEE 457. Letter grade, S-U by permission only. Lab, T W or R 1:25–4:25; 1 weekend field trip. Fee, $12 (for food on field trip). Offered alternate years. N. G. Hairston, Jr., staff.

Laboratories and field trips devoted to studies of the biological, chemical, and physical properties of lakes and other freshwater environments. Exercises focus on understanding the freshwater environment, on experimentation, and on understanding ecological processes within lakes. Optional vertebrate dissection (fish) during one laboratory exercise and during a portion of the weekend field trip.

BIOEE 460 Theoretical Ecology

Spring. 4 credits. Enrollment limited. Prerequisites: completion of the Biological Sciences mathematics requirement or equivalent, and either one additional semester of mathematics, statistics or modeling (e.g., BEE 250, BEE 367, NTRES 305, NTRES 340, NTRES 410, BIONB 422) or permission of instructor. S-U grades optional. Lecs, T R 1:25–2:40; lab, M 2:00–4:25. Offered alternate years. S. P. Ellner.

An introduction to the models used to construct ecological theory and analyze data on ecological dynamics, and to the mathematical and computer methods used to analyze these models. Applications from individual decision-making through multispecies and spatial dynamics introduce the main themes in theoretical ecology: optimization, dynamics, and the links between process and pattern. The lab includes instruction in computer programming and review of mathematical methods.

BIOEE 462 Marine Ecology (also EAS 462)

Spring. 3 credits. Limited to 75 students. Prerequisite: BIOEE 261. Lecs and discs, M W F 10:10. Offered alternate years. C. D. Harvell.

Lectures and discussion focus on current research in broad areas of marine ecology with an emphasis on processes unique to marine systems. A synthetic treatment of

multiple levels of organization in marine systems including organismal, population, community, ecosystems, and evolutionary biology. Examples are drawn from all types of marine habitats, including polar seas, temperate coastal waters, and tropical coral reefs.

BIOEE 463 Plant Ecology and Population Biology, Lectures
Fall. 3 credits. Prerequisite: BIOEE 261 or 278 or equivalents, or permission of instructor. Recommended: some taxonomic familiarity with vascular plants and concurrent enrollment in BIOEE 465. Lecs, M W F 11:15. Offered alternate years. M. A. Geber, P. L. Marks.
This course examines the biological and historical factors affecting the structure of plant communities, and the distribution, abundance, and population dynamics of individual species. The influence of the environment, disturbance history, competition, and herbivory on the organization of plant communities are considered. Plant populations are also studied through an analysis of plant life histories and plant-plant and plant-animal interactions. Throughout the course an attempt is made to blend empirical patterns, experimental results, and theory. Readings are drawn from the primary literature.

[BIOEE 464 Macroevolution
Spring. 4 credits. Limited to 25 students. Prerequisite: BIOEE 278 or permission of instructor. Grad students interested in taking this course are strongly encouraged to preregister. S-U grades optional, with permission of instructor. Lecs, T R 10:10–11:25; disc, 1 hour each week TBA. Offered alternate years. Not offered 2002–2003. A. R. McCune.
An advanced course in evolutionary biology centered on large-scale features of evolution. Areas of emphasis include patterns and processes of speciation, phylogeny reconstruction, the origin of variation, causes of major evolutionary transitions, and patterns of diversification and extinction in the fossil record. Discussion of these problems involve data and approaches from genetics, morphology, systematics, paleobiology, development, and ecology.]

BIOEE 465 Plant Ecology and Population Biology, Laboratory
Fall. 1 credit. Prerequisite: concurrent enrollment in BIOEE 463. Lab, F 12:05–5:00. Offered alternate years. M. A. Geber, P. L. Marks.
Field and laboratory exercises are designed to give firsthand experience with the ecology and population biology of plants. Emphasis is on making observations and measurements of plants in the field and greenhouse, and on data analysis.

BIOEE 466 Physiological Plant Ecology, Lectures
Spring. 3 credits. Limited to 45 students. Prerequisite: BIOEE 261 or introductory plant physiology. S-U grades optional, with permission of instructor. Lecs, M W 8:40–9:55; optional disc TBA. Offered alternate years. J. P. Sparks.
A detailed survey of the physiological approaches used to understand the relationships between plants and their environment. Lectures explore: physiological adaptation; limiting factors; resource acquisition and allocation; photosynthesis, carbon, and energy balance; water use and water relations; nutrient relations; linking physiology, development, and morphology; stress physiology; life history and physiology; the evolution of physiological performance; and physiology at the population, community, and ecosystem levels. Readings draw from the primary literature and textbooks.

BIOEE 467 Seminar in the History of Biology (also HIST 415, B&SOC 447, and S&TS 447)
Summer (6-week session). 4 credits. Limited to 18 students. S-U grades optional. W. B. Provine.
Specific topic changes each year.

BIOEE 468 Physiological Plant Ecology, Laboratory
Spring. 2 credits. Limited to 15 students. Prerequisite: previous or concurrent enrollment in BIOEE 466. Lab, W 1:25–4:25, plus additional lab hours TBA. Offered alternate years. J. P. Sparks.
A detailed survey of the physiological approaches used in understanding the relationships between plants and their environment. Laboratories apply physiological techniques to specific ecological problems and cover aspects of experimental design and computer-aided data analysis. Most laboratories run past the three-hour period, with students spending an average of three hours/week in additional lab time for this course.

[BIOEE 469 Food, Agriculture, and Society (also B&SOC 469 and S&TS 469)
Spring. 3 credits. Limited to 20 students. Prerequisite: an introductory ecology course or permission of instructor. S-U grades optional. Lecs, T R 1:25–2:40. Not offered 2002–2003. A. G. Power.
A multidisciplinary course dealing with the social and environmental impact of food production in the United States and developing countries. Agroecosystems of various kinds are analyzed from biological, economic, and social perspectives. The impacts of traditional, conventional, and alternative agricultural technologies are critically examined in the context of developed and developing economies. Specific topics include pest management, soil conservation, plant genetic resources, biotechnology, and sustainable development.]

[BIOEE 471 Mammalogy
Fall. 4 credits. Recommended: BIOEE 274. S-U grades optional, with permission of instructor. Carpooling to the Vertebrate Collections at Cornell Business and Technology Park is necessary several times during the semester. Fee, $15. Lecs, M W F 12:20; lab, M T or W 1:25–4:25; 1 weekend field trip required. Offered alternate years. Not offered 2002–2003. Staff.
Lectures on the evolution, classification, distribution, and adaptations of mammals. Laboratory and fieldwork on systematics, ecology, and natural history of mammals of the world, with primary emphasis on the North American fauna. Systematics laboratories held in the museum at Research Park. Live animals are studied in the field and are sometimes used in the laboratory for nondestructive demonstrations or experiments. The systematics laboratory exercises are based on museum specimens.]

BIOEE 472 Herpetology
Spring. 4 credits. Limited to 35 students. Recommended: BIOEE 274. S-U grades optional, with permission of instructor. Fee, $30. Lecs, T R 12:20; labs, T R 1:25–4:25; occasional field trips and special projects. Offered alternate years. H. W. Greene.
Lectures cover various aspects of the biology of amphibians and reptiles, including evolution, zoogeography, ecology, behavior, and physiology. Laboratory topics include systematics, morphology, and behavior. Live animals are studied in the field and are used in the laboratory for nondestructive demonstrations and experiments. The systematics laboratory exercises are based on museum specimens and dissection of preserved materials.

[BIOEE 473 Ecology of Agricultural Systems (also CSS 473)
Fall. 3 credits. Limited to 45 students. Prerequisite: BIOEE 261 or permission of instructor. S-U grades optional. During the first 6 weeks of class, the Thursday meetings may run later because of field trips. Lecs and discs, T R 2:30–3:45. Offered alternate years. Not offered 2002–2003. A. G. Power, E. C. M. Fernandes.
Analysis of the ecological processes operating in agricultural systems, with an emphasis on the interactions between organisms. Topics include nutrient dynamics in agroecosystems, plant competition and facilitation, intercropping, the ecology of species invasions, mutualism in agroecosystems, plant-herbivore relations, plant-pathogen interactions, biological pest control, and evolutionary processes in agriculture. Case studies from both the tropics and the temperate zone are used to illustrate important concepts.]

BIOEE 474 Forensic Anthropology and Human Biology (also ANTHR 474)
Spring. 5 credits. Limited to 16 students. Prerequisite: one year of introductory biology or ANTHR 101 or permission of instructor. Recommended: permission of instructor by preregistering in E231 Corson. Independent research project required. Lecs and labs, T R 10:10–12:05; additional hours TBA. Offered alternate years. K. A. R. Kennedy.
Forensic anthropology within the forensic sciences is covered in a broad survey of laboratory and field methods for students with interest in this applied area of biological anthropology. Emphasis is upon human skeletal biology, pathology, age and sex determination, and relevant techniques for the archaeologist and forensic anthropologist.

[BIOEE 475 Ornithology
Spring. 4 credits. Limited to 35 students. Prerequisite: permission of instructor by preregistering in E235 Corson. Recommended: BIOEE 274. S-U grades optional, with permission of instructor. Carpooling to the Laboratory of Ornithology is necessary. Fee, $15. Lecs and labs, T R 12:20–4:25; occasional field trips and special projects. Offered alternate years. Not offered 2002–2003. D. W. Winkler.
Lectures cover various aspects of the biology of birds, including anatomy, physiology, systematics, evolution, behavior, ecology, and biogeography. Laboratory includes dissection of dead material, studies of skeletons and plumages, and specimen identification of avian families of the world and species of New York. Independent projects emphasize research skills.]

BIOEE 476 Biology of Fishes
Fall. 4 credits. Limited to 24 students. Recommended: BIOEE 274 or equivalent experience in vertebrate zoology. S-U grades optional, with permission of instructor. A small lab fee may be required. Lecs, M W F 10:10; lab, M 1:25–4:25; with additional lab time TBA; 2 field trips. Offered alternate years. A. R. McCune.
An introduction to the study of fishes: their structure, evolution, distribution, ecology, physiology, behavior, classification, and identification, with emphasis on local species. Two field trips, including one full day weekend trip required. Live animals are studied in the field and are sometimes used in the laboratory for nondestructive demonstrations or experiments. The systematics and dissection laboratories use preserved specimens.

[BIOEE 477 Marine Invertebrates Seminar
Fall. 1 credit. Prerequisite: BIOEE 373 or permission of instructor. S-U grades only. Sem, 1 hour each week TBA. Offered alternate years. Not offered 2002–2003. C. D. Harvell, J. G. Morin.
Discussions and directed readings center around current research themes in Invertebrate Biology. Designed as an on-campus companion course to the field-based BIOEE 373, Biology of the Marine Invertebrates. Students will write individual research essays based on projects done in the field.]

BIOEE 478 Ecosystem Biology
Spring. 4 credits. Prerequisite: BIOEE 261 or equivalent. S-U grades optional. Lecs and discs, T R 10:10–12:05. Offered alternate years. Staff.
Analysis of ecosystems in terms of energy flow and nutrient cycles, emphasizing an experimental approach and comparative aspects of terrestrial, freshwater, and marine ecosystems. We consider anthropogenic effects on ecosystems, such as from acid precipitation and offshore oil pollution. Also includes analysis of climate change and regional environmental change from an ecosystem perspective.

[BIOEE 479 Paleobiology (also EAS 479)
Fall. 4 credits. Prerequisites: one year of introductory biology for majors and either BIOEE 274, EAS 375, BIOEE 373, or permission of instructor. S-U grades optional. Lecs, M W F 12:20; lab W 2:00–4:25. Offered alternate years. Not offered 2002–2003. W. Allmon.
For description, see EAS 479.]

[BIOEE 490 Topics in Marine Biology
Spring. 2 credits. May be repeated for credit. Primarily for undergraduates. Limited to 15 students. Prerequisite: permission of instructor. S-U grades optional. Lec, F 1:25–3:20. Offered alternate years. Not offered 2002–2003. J. Morin, M. Shulman.
Seminar courses on selected topics in marine biology; may include laboratory or field trips. Topics and time of organizational meeting are shown in departmental course offerings listed on the web site.]

BIOEE 660 Field Studies in Ecology and Systematics
Fall or spring. Variable credit. Prerequisites: BIOEE 261, a taxon-oriented course, and permission of instructor. S-U grades optional, with permission of instructor. Lecs and field trips TBA. Estimated costs: TBA. Staff.
This course provides students with opportunities to learn field techniques and new biotas by participating in an intensive series of field exercises. Extended field trips may be scheduled during fall break, intersession, or spring break. The regions visited, trip objectives, and other details are announced by the various instructors at an organizational meeting held at the beginning of the semester. Meetings on campus are devoted to orientation and reports on completed projects.

Section 01: Life Histories of Marine and Freshwater Invertebrates
Spring. 2 credits. Prerequisite: undergraduates must have previous experience or course work with marine or freshwater invertebrates. Extended field trips over winter break. Fee, TBA (to cover transportation and housing). Offered alternate years. C. D. Harvell, N. G. Hairston, Jr.
Field trips to the Yucatan Coast of Mexico. Students employ experimental approaches to study the ecology of invertebrate life histories.

[Section 02: Graduate Field Course in Ecology
Spring. 3 credits. Restricted to graduate students. A fee will be required to help cover food and lodging for trip to Florida. Offered alternate years. Not offered 2002–2003. P. L. Marks, R. B. Root.
The course is designed to give graduate students experience in defining questions and designing field investigations. The class is based at the Archbold Biological Station in central Florida over spring break and during the following week. The class visits several ecosystems including sand pine scrub, cattle ranches, cypress swamps, everglades, and coral reefs.]

BIOEE 661 Environmental Policy (also ALS 661 and B&SOC 461)
Fall and spring. 3 credits each term. (Students must register for 6 credits each term, since an "R" grade is given at the end of the fall term.) Limited to 12 students. Prerequisite: permission of instructor. Sem, R 2:30–4:30. D. Pimentel.
This course focuses on complex environmental issues. Ten to twelve students, representing several disciplines, investigate significant environmental problems. The research team spends two semesters preparing a scientific report for publication in *Science* or *BioScience*. Thus far, every study has been published.

[BIOEE 665 Limnology Seminar
Spring. 1 credit. May be repeated for credit. Primarily for graduate students; written permission of instructor required for undergraduates. S-U grades optional. Sem TBA. Offered alternate years. Not offered 2002–2003. N. G. Hairston, Jr.
A seminar course on advanced topics in freshwater ecology.]

[BIOEE 668 Principles of Biogeochemistry
Spring. 4 credits. Limited to 20 students. Prerequisite: solid background in ecology, environmental chemistry, or related environmental science. Permission of instructor required for undergraduates. S-U grades optional. Lecs and discs, T R 10:10–12:05. Offered alternate years. Not offered 2002–2003. Staff.
Lectures cover the biotic controls on the chemistry of the environment and the chemical control of ecosystem function. Emphasis is on cycles of major elements and minor elements globally and in selected ecosystems, stressing the coupling of element cycles. A comparative approach is used to illustrate similarities and differences in element cycling among ecosystems. Analysis of both theoretical and applied issues, including global atmospheric changes and factors controlling the acidification of lakes and soils.]

[BIOEE 669 Plant Ecology Seminar
Spring. 1 credit. May be repeated for credit. Suggested for students majoring or minoring in plant ecology. S-U grades optional. Sem TBA. Not offered 2002–2003. Staff.
Includes review of current literature, student research, and selected topics of interest to participants.]

BIOEE 670 Graduate Seminar in Vertebrate Biology
Fall or spring. 1 credit. May be repeated for credit. Primarily for graduate students; written permission of instructor required for undergraduates. S-U grades only. Sem TBA. Staff.
Seminar presentations and discussions by students on areas of current research in vertebrate biology. Topics vary from semester to semester.

BIOEE 673 Human Evolution: Concepts, History, and Theory (also ANTHR 673)
Fall. 3 credits. Prerequisite: one year of introductory biology or ANTHR 101 or permission of instructor. Lec, M 2:30; sem and disc, W 7:30–9:30 p.m. Offered alternate years. K. A. R. Kennedy.
A survey of the historical background of present-day concepts of human evolutionary variations and adaptations in space and time. The formation of biological anthropology as an area of scientific inquiry within the social and biological sciences is reviewed. Students select their own topics within a broad range of readings in the history of Western concepts of human origins, diversity, and place in nature.

BIOEE 760 Special Topics in Evolution and Ecology
Fall or spring. 1–3 credits. May be repeated for credit. Enrollment limited. S-U grades optional, with permission of instructor. Staff.
Independent or group intensive study of special topics of current interest. Content varies and is arranged between student and staff member.

BIOEE 763 Workshop in Biogeochemistry
Fall or spring. 1 credit. May be repeated for credit. Limited to 15 students. Prerequisite: BIOEE 668. S-U grades only. Workshop and disc, TBA. Staff.
Provides a workshop-forum in which graduate students interact with invited world-leaders in biogeochemistry. Workshop topics change each semester. A one-week workshop will be preceded by seven, one-hour preparatory discussions of readings.

BIOEE 767 Current Topics in Ecology and Evolutionary Biology
Fall. 4 credits. Prerequisite: permission of instructor required for undergraduates. S-U grades only. Lecs and discs, T R 10:10–12:05. Staff.

Critical evaluation and discussion of theory and research in ecology and evolutionary biology. Lectures by faculty and student-led discussions of topics in areas of current importance.

BIOEE 899 M.S. Thesis Research
Fall or spring. 1–15 credits. Prerequisite: admission to the Field of Ecology and Evolutionary Biology. S-U grades optional. E&EB field faculty.
Thesis research conducted by an M.S. student in the Field of Ecology and Evolutionary Biology with advice and consultation of a major professor who is a member of the Field.

BIOEE 999 Ph.D. Dissertation Research
Fall or spring. 1–15 credits. Prerequisite: admission to the Field of Ecology and Evolutionary Biology as a Ph.D. student. S-U grades optional. E&EB field faculty.
Dissertation research conducted by a Ph.D. student in the Field of Ecology and Evolutionary Biology with advice and consultation of a major professor who is a member of the Field.

Related Courses in Other Departments

Agricultural and Biological Engineering (BEE 371, 456)

Anthropology (ANTHR 375)

Biological Sciences (BIO G 400, 498, 499; BIOGD 387, 481, 484; BIOMI 290, 414, 418, BIONB, 221, 422, 427; BIOPL 241, 248, 447, 448)

Biology and Society (S&TS 206, 427)

Crop and Soil Sciences (CSS 260, 366, 415–416, 420)

Earth and Atmospheric Sciences (EAS 101–102, 204, 302, 321)

Entomology (ENTOM 201–215, 331, 453, 470–471)

Natural Resources (NTRES 201–279-271, 301–302, 305, 418–419)

Plant Pathology (PLPA 309, 319)

Shoals Marine Laboratory (BIOSM 303–499)

Statistics (BTRY 101–102, 261, 301, 451; ILRST 210–411)

GENETICS AND DEVELOPMENT (BIOGD)

BIOGD 132 Orientation Lectures in Molecular Biology and Genetics (also BIOBM 132)
Spring, weeks 1–3. No credit. Primarily for freshmen, sophomores, and transfer students. S-U grades only. Lec, S 10:10, for first three S of semester. Staff.
Discussions by six professors about their research and promising new areas for research in the future.

[BIOGD 184 Understanding Genetics
Spring. 3 credits. May not be taken for credit after BIOGD 281 or 282. This course may be used toward the science distribution requirement of the College of Arts and Sciences and the Group B distribution requirement of the College of Agriculture and Life Sciences. This course may not be used to fulfill the requirements for any program of study in the biological sciences major. S-U grades optional. Lecs, M W F 2:30. Offered alternate years. T. D. Fox.
An introduction to genetics for students majoring in fields other than biology. Genetics is a rapidly developing science that is providing insight into all aspects of biology and practical tools which increasingly affect our lives. This course shows how major conclusions about inheritance have been derived from the experimental evidence, drawing on examples from the biology of humans, other animals, plants, fungi, and bacteria. It also illustrates current and future applications of genetic discoveries. For example, the basic principles of inheritance, in conjunction with methods for the isolation and detection of specific gene fragments, is used to understand the detection of genetic diseases and the identification of individuals (DNA fingerprinting). Other topics to be covered include the origin of mutations, use of genetic methods to alter the properties of organisms and the influence of inheritance on behavior.]

BIOGD 281 Genetics
Fall, spring, or summer (8-week session). 5 credits. Not open to freshmen in fall semester. Enrollment may be limited to 200 students. Prerequisite: one year of introductory biology or equivalent. No admittance after first week of classes. Students do not choose lab sections during course enrollment; lab assignments are made during first day of classes. Lecs, T R 10:10–12:05; lab, T or W or R or F 2:30–4:25. Problem-solving sessions strongly recommended, T or W 8:30–9:45 (additional session by arrangement). T. D. Fox, M. L. Goldberg, R. J. MacIntyre.
A general study of the fundamental principles of genetics in eukaryotes and prokaryotes. Discussions cover gene transmission, gene action and interaction, gene linkage and recombination, gene structure, gene and chromosome mutations, genes in populations, and extrachromosomal inheritance. Aspects of recombinant DNA technology are discussed. In the laboratory, students perform experiments with microorganisms and conduct an independent study of inheritance in *Drosophila*.

BIOGD 282 Human Genetics
Spring. 2 or 3 credits (2 credits if taken after BIOGD 281). Each discussion limited to 20 students. Prerequisite: 1 year of introductory biology or equivalent; permission of instructor required for students who have taken BIOGD 281. S-U grades optional. Lecs, M W 10:10 (Lecs, also F 10:10 first 4 weeks only); disc, R 10:10 or F 10:10 or 11:15. Staff.
A course designed for nonmajors. Lecturers provide the technical background needed to understand controversial personal, social, and legal implications of modern genetics that are discussed in section meetings.

BIOGD 385 Developmental Biology
Fall. 3 credits. Prerequisite: BIOGD 281. Lecs, M W F 11:15. K. J. Kemphues.
An introduction to the morphogenetic, cellular, and genetic aspects of the developmental biology of animals.

BIOGD 389 Embryology
Spring. 3 credits. Preference given to seniors. Prerequisites: 1 year of introductory biology and a knowledge of mammalian adult anatomy. Lecs, TBA; labs, TBA. Staff.
A course in the embryonic development of terrestrial vertebrate animals, with emphasis on the comparative aspects of morphogenesis and function at the tissue and organ levels. The laboratory has a strong morphogenetic bias, emphasizing the comparative aspects of developmental anatomy and preparation for veterinary medical studies.

[BIOGD 394 Circadian Rhythms (also ENTOM 394 and BIONB 394)
Fall. 2 credits. Prerequisite: ENTOM 212, or BIOGD 281, or BIONB 221 or 222, or permission of instructor. S-U grades optional. Lec, W 7:30–9:10 p.m. Offered alternate years. J. Ewer.
For description, see ENTOM 394.]

BIOGD 439 Molecular Basis of Human Disease (also BIOBM 439)
Fall. 3 credits. Prerequisites: BIOBM 330 or BIOBM 331–332 and genetics (e.g., BIOGD 281) or permission from instructor. Recommended: cell biology (e.g., BIOBM 432 or BIOAP 316) and physiology (e.g., BIOAP 311 or BIOAP 458). S-U grades optional. Lecs, T R 10:10–11:25. W. L. Kraus.
This course will examine how changes in the normal expression, structure, and activity of gene products caused by genetic mutations, epigenetic phenomena, and environmental agents lead to human diseases. The material will focus on how these changes lead to alterations in normal cellular processes, as well as the resulting physiological consequences. Topics will be selected from hormone insensitivity syndromes, inborn errors of metabolism, gene fusions resulting in hybrid proteins, gene amplification, gene inactivation, disruption of signaling pathways, disruption of metabolic pathways, and the molecular actions of infectious agents and environmental toxins. Examples of diseases will be selected to emphasize various aspects of genetics, molecular biology, cell biology, physiology, immunology, and endocrinology that have been presented in other courses. In addition, the methods used to identify the underlying biochemical and genetic basis of the diseases, as well as possible pharmaceutical and genetic therapies for treating the diseases, will be presented. A portion of each class period will be devoted to discussion and practice questions.

[BIOGD 450 Vertebrate Development
Spring. 3 credits. Prerequisite: introductory biology. S-U and letter grades. Offered alternate years. Lecs, T R 11:40–12:55. K. Whitlock.
This course is designed to examine the development of characteristics that make vertebrates unique. The course starts with an introduction to recent evolutionary and molecular approaches to understanding the rise of vertebrate structures. The development of vertebrate structures, such as neural crest, specialized sense organs, and limbs, is examined in detail with emphasis on the cellular and molecular events controlling their development.]

BIOGD 480 Seminar in Developmental Biology
Fall or spring. 1 or 2 credits. Will be offered fall 2002. May be repeated for credit. Limited to juniors and seniors. Prerequisite: BIOGD 281. S-U grades only. Seminar TBA. Staff.

BIOGD 481 Population Genetics
Fall. 4 credits. Prerequisite: BIOGD 281, BIOEE 278, or equivalents. Lecs, M W F 10:10; disc, M 2:30 or T 1:25. Staff.
Population genetics is the study of the transmission of genetic variation through time and space. The class explores how to quantify this variation, what the distribution of variation tells us about the structure of natural populations, and about the processes that lead to evolution. Topics include the diversity and measurement of genetic variation, mating and reproductive systems, selection and fitness, genetic drift, migration and population structure, mutation, multilocus models, the genetics of speciation, quantitative traits, and the maintenance of molecular variation. Emphasis is placed on DNA sequence variation, and the interplay between theory and the data from experiments and natural populations. Specific case studies include the population genetic issues involved in DNA fingerprinting, the genetic structure and evolution of human populations, and the study of adaptation at the molecular level. Examples are drawn from studies of animals, plants, and microbes.

BIOGD 482 Human Genetics and Society
Fall. 4 credits. Enrollment limited to 24 senior biological sciences majors, with preference given to students studying genetic and molecular biology. Prerequisites: BIOGD 281 and BIOBM 330 or 333 or 331 and 332, and permission of instructor. S-U grades optional. T R 2:30–4:25. R. A. Calvo.
Presentation of some of the science and technology of human genetics, plus discussion of the ethical, social, and legal implications of recent advances in the field. Among the topics considered are assisted reproductive strategies, eugenics, genetic counseling, genetic screening (pre-implantation, prenatal, neonatal, pre-symptomatic, carrier, and workplace), wrongful life and wrongful birth, genetic effects of abused substances, genetics and behavior, human cloning, and therapy for genetic diseases. Students lead many discussions. There is a major writing component to the course.

BIOGD 483 Advanced Developmental Biology
Spring. 3 credits. Prerequisites: BIOGD 281; BIOBM 332 or 330 or 333; and BIOGD 385 or permission of instructor. Lecs, T R 2:30–4:00. Offered alternate years. M. F. Wolfner.
An advanced course in developmental biology, with emphasis on the molecular events underlying developmental processes. Simultaneously, a molecular/cell biology course that focuses on how development modulates and uses transcriptional, post-transcriptional, translational, and post-translational regulation of gene expression and cellular events such as signal transduction and cell-cell communication. Numerous developmental systems are discussed and analyzed in microorganisms, plants and, especially, animals including fruit flies, nematode worms, and vertebrates such as mice, frogs, and humans. Course readings include original research articles. Discussion emphasizes specific experiments and approaches, and results and their interpretation.

[BIOGD 484 Molecular Evolution
Spring. 3 credits. Prerequisites: BIOGD 281 and organic chemistry. Lecs, M W 8:40–9:55. Offered alternate years. R. J. MacIntyre.
An analysis of evolutionary changes in genes and their protein products. Theories on the evolution of the genetic code, the construction of phylogenetic trees from biochemical data and the role of gene duplications in evolution are discussed. The second half of the course concerns the evolution and the organization of genomes from viruses to higher eukaryotes, including the evolution of satellite DNA sequences and transposable elements.]

BIOGD 485 Bacterial Genetics (also BIOMI 485)
Fall. 2 credits. Graduate students, see BIOMI 685. Prerequisite: BIOGD 281. Recommended: BIOMI 290 and BIOBM 330 or 331 and 332 or 333. Lecs, W 7:30–9:25 p.m. Staff.
For course description, see BIOMI 485.

BIOGD 486 Advanced Eukaryotic Genetics
Spring. 4 credits. Enrollment may be limited to 50 students. Prerequisites: BIOGD 281, BIOBM 330 or 333 or 331 and 332. S-U grades optional. Lecs, T 12:20–2:15 and R 12:20–1:10; disc R 1:25–2:15 or F 11:15–12:05. E. E. Alani.
The course develops fundamental skills in eukaryotic genetic analysis through lectures and by reading, analyzing, and presenting research articles. Concepts are presented within the context of a well-studied field, such as chromosome segregation. The basic tools that have been developed to study this field are used to analyze other topics such as vegetative and meiotic cell cycle control, embryonic development, pathogen resistance in plants, and human genetics.

BIOGD 600 Development of Sensory Systems
Spring. 2 credits. Prerequisites: introductory biology, genetics, development, and neurobiology, or permission of instructor. S-U or letter grades. Lec, M 7:00–8:40 p.m. Offered alternate years. K. Whitlock.
This course explores the unique and shared mechanisms used in sensory system development of both vertebrates and invertebrates. The first class of the course provides a general introduction to the development of sensory systems in vertebrates and invertebrates. Following classes involve the reading of current and classic papers in sensory system development. Students choose a topic and articles from a list provided by the instructor. Students are responsible for an oral presentation and short paper.

[BIOGD 682 Fertilization and the Early Embryo
Spring. 2 credits. Prerequisites: BIOGD 281; BIOBM 332, 330 or 333; and BIOGD 385 or permission of instructor. Lec, R 2:30–4:25. Offered alternate years. Next offered 2004. M. F. Wolfner.
This course treats the earliest events in the formation of a new organism. The methods and findings of genetic, developmental, cell and molecular analyses are discussed. Readings in the recent literature and discussions focus on pre-gastrulation embryos from several animal species. Topics include fertilization (sperm/egg binding, sperm entry into egg), pronuclear fusion, egg activation, initiation and terminating the cleavage, division period, cytoplasmic determinants, and changes in nuclear and cytoplasmic architecture.]

BIOGD 684 Advanced Topics in Population Genetics
Spring. 2 credits. Limited to 20 students. Prerequisites: BIOGD 481 or equivalent and written permission of instructor. S-U grades optional. Lec, T 2:30–4:25. Offered alternate years. C. F. Aquadro.
An in-depth exploration of current areas of research in population genetics. Readings primarily from recent books and the current literature. Specific topics are announced the previous fall and in the division's catalog supplement. Format includes lectures, discussion, and presentations by students.

BIOGD 685 Advanced Bacterial Genetics (BIOMI 485)
Fall. 2 credits. Limited to graduate students in Biological Sciences; see BIOMI 485. Prerequisites: BIOGD 281 or equivalent, BIOBM 330 or 331 and 332 or equivalent, and permission of instructor. Recommended: BIOMI 290 or equivalent. Lec, W 7:30–9:25; disc, R 10:10–11:00. Staff.
For course description, see BIOMI 485.

[BIOGD 687 Developmental Genetics
Fall. 2 credits. Limited to 20 students. Prerequisites: BIOGD 281 and 385 or their equivalents. S-U grades optional. Lec TBA. Offered alternate years. Next offered fall 2003. K. J. Kemphues.
Selected topics focus on the use of genetic analysis in understanding mechanisms of development. Topics are drawn primarily from studies in fruitflies, nematodes, mice and fish. Possible topics include pattern formation, cell lineage, neural development, maternal information in development, germ cell development, sex determination, and intercellular communication. Students read current literature and are encouraged to discuss each topic in class.]

BIOGD 780 Current Topics in Genetics
Fall or spring. 2 credits. May be repeated for credit. Primarily for graduate students, with preference given to majors in the Field of Genetics, written permission of instructor required for undergraduates. Limited to 20 students. No auditors. S-U grades optional, with permission of instructor. Seminar TBA. Staff.

BIOGD 781 Problems in Genetics and Development
Fall. 2 credits. Limited to first-year graduate students in the Field of Genetics and Development. Disc TBA. Staff.
An introduction to the research literature in selected areas through weekly problem sets and discussions.

BIOGD 782–783 Current Genetics/Development Topics
Spring. 1/2 or 1 credit for each topic. May be repeated for credit. S-U grades only. Lectures and seminars on specialized topics to be announced. Hours TBA. Staff.

BIOGD 786 Research Seminar in Genetics and Development
Fall and spring. 1 credit. Limited to and required of second-, third-, and fourth-year graduate students in Genetics and Development. S-U grades only. Sem, TBA. Staff.
Each graduate student presents one seminar per year based on his or her thesis research. The student then meets with the thesis

committee members for an evaluation of the presentation.

BIOGD 787 Seminar in Genetics and Development
Fall and spring. 1 credit. Limited to graduate students in Genetics and Development. S-U grades only. Sem, TBA. Staff.
Seminars in current research in genetics and developmental biology conducted by distinguished visitors and staff.

Related Courses in Other Departments

Advanced Plant Genetics (Plant Breeding 606)

Animal Development (Veterinary Anatomy 507)

Biosynthesis of Macromolecules (Biological Sciences [BIOBM] 633)

Current Topics in Biochemistry (Biological Sciences [BIOBM] 731–736)

Evolutionary Biology (Biological Sciences [BIOEE] 278)

Laboratory in Molecular Biology and Genetic Engineering of Plants (Biological Sciences [BIOPL] 347)

Laboratory in Plant Molecular Biology (Biological Sciences [BIOPL] 641)

Molecular Biology and Genetic Engineering of Plants (Biological Sciences [BIOPL] 343)

Plant Cytogenetics (Plant Breeding 446)

Plant Genome Organization (PLBR 653–03)

Plant Growth and Development (Biological Sciences [BIOPL] 644)

Plant Molecular Biology I (Biological Sciences [BIOPL] 653)

Plant Molecular Biology II (Biological Sciences [BIOPL] 652)

Protein-Nucleic Acid Interactions (Biological Sciences [BIOMI] 692)

The Nucleus (Biological Sciences [BIOBM] 639)

Undergraduate Research in Biology (Biological Sciences [BIO G] 499)

Molecular Neurobiology BIONB 420/720 (also BIOBM 435/735)

MICROBIOLOGY (BIOMI)

BIOMI 192 Microorganisms on the Planet Earth
Summer. 3 credits. May not be taken for credit after BIOMI 290. S-U grades optional. Lecs, M-F 10:00–11:15. R. P. Mortlock.
A course in microbiology designed to introduce students, who have a limited background in science, to the microorganisms that populate our planet earth. Among the microorganisms studied are the bacteria, the archaebacteria, some of the single-celled plants and animals, and the viruses. Topics covered are the basic nature of microorganisms, their evolution on earth, their composition and growth, their role in the ecology of this planet, their role in human history and disease, and their use in bioengineering. This course is not a prerequisite for advanced courses in microbiology.

BIOMI 290 General Microbiology Lectures
Fall, spring, or summer (6-week session). 2 or 3 credits (2 credits if taken after BIOMI 192). Prerequisites: 1 year of introductory biology for majors and 1 year of college chemistry, or equivalent. Recommended: concurrent registration in BIOMI 291. Lecs, M W F 11:15–12:05. Staff.
A comprehensive overview of the biology of microorganisms, with emphasis on bacteria. Topics include microbial cell structure and function, physiology, metabolism, genetics, diversity, and ecology. Applied aspects of microbiology are also covered such as biotechnology, the role of microorganisms in environmental processes, and medical microbiology.

BIOMI 291 General Microbiology Laboratory
Fall or spring, 2 credits. Summer (6-week session), 2 credits. Prerequisite: concurrent or previous enrollment in BIOMI 290. Lec, F 12:20; labs, M W 12:20–2:15 or 2:30–4:25, or T R 10:10–12:05, 12:20–2:15, or 2:30–4:25. C. M. Rehkugler.
A study of the basic principles and techniques of laboratory practice in microbiology, and fundamentals necessary for further work in the subject.

BIOMI 292 General Microbiology Discussion
Spring. 1 credit. Prerequisite: concurrent or previous enrollment in BIOMI 290. S-U grades only. Disc TBA. C. M. Rehkugler.
A series of discussion groups in specialized areas of microbiology to complement BIOMI 290.

BIOMI 331 General Parasitology (also VETMI 331)
Spring. 2 credits. Prerequisites: one year of introductory biology. Lecs, T R 3:35–4:25. D. Bowman.
An introduction to the basic animal parasites, stressing systematics, taxonomy, general biology, ecological interactions, and behavior of non-medically important groups. The course introduces the major animal parasites, protozoan, nematode, platyhelminth, acanthocephalan, annelid, and arthropod.

BIOMI 391 Advanced Microbiology Laboratory
Fall. 3 credits. Prerequisites: BIOMI 290, 291, and BIOBM 330 or 331 or 333. Preference given to biological sciences students in the microbiology program of study. Lab, M W 1:25–4:25; disc, F 1:25–2:15. J. B. Russell, W. C. Ghiorse, J. P. Shapleigh, S. H. Zinder.
A laboratory course that illustrates basic principles of experimental microbiology. The course is organized into four modules which last three weeks each: (1) ecology, (2) physiology, (3) genetics, and (4) structure and function. Students are encouraged to take this course during their third year of study.

BIOMI 394 Applied and Food Microbiology (also FOOD 394)
Fall. 2–3 credits. Prerequisites: BIOMI 290–291. M W F 12:20–1:10. 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. Issues related to the biochemistry, genetics, and physiology of microorganisms important in these processes are reviewed. A two-credit core section on food microbiology is complemented by a one-credit section on industrial/biotechnology applications.

BIOMI 397 Environmental Microbiology (also CSS 398)
Fall. 3 credits. Prerequisites: BIOEE 261 or BIOMI 290 or CSS (SCAS) 260 or permission of instructor. Lecs, M W F 10:10. W. C. Ghiorse, E. L. Madsen.
The biological properties, evolution, and behavior of microorganisms in natural systems are discussed in relation to past and present environmental conditions on Earth and other living planets. The functional role of microorganisms in ecologically and environmentally significant processes is also considered through discussion of specific topics such as nutrient and toxic elemental cycles, transformation of pollutant chemicals, wastewater treatment, environmental biotechnology, and astrobiology.

BIOMI 404 Pathogenic Bacteriology and Mycology (also VETMI 404)
Spring. 2 or 3 credits (3 credits with lecture and seminar with permission of instructor for undergraduates). Prerequisites: BIOMI 290 and 291. Strongly recommended: BIO G 305. Lecs, M W 10:10; sem, F 10:10. Offered alternate odd years. D. Debbie.
This is a course in medical microbiology, presenting the major groups of bacterial and mycotic pathogens important to human and veterinary medicine. The emphasis of this course is infection and disease pathogenesis. Topics include disease causality; interactions of host, pathogen and environment, including immunity to bacteria and fungi; and principles of antimicrobial therapy and drug resistance. A companion seminar addresses the current and classic literature related to microbial pathophysiology on the cellular and molecular level.

[BIOMI 408 Viruses and Disease I (also VETMI 408)
Spring. 2 credits. Prerequisites: BIOMI 290, 291; BIO G 305; and permission of instructor. Recommended: BIOGD 281. Lecs, M W 7:30 p.m. Offered alternate even years. J. Casey.
The course covers basic concepts in virology with emphasis on virus-host interactions, strategies for gene regulation, and mechanisms of pathogenicity. Selected viral infections that result in immune dysfunction and neoplasis are highlighted in the context of approaches to prevent or reduce the severity of diseases.]

BIOMI 409 Viruses and Disease II (also VETMI 409)
Fall. 2 credits. Prerequisites: BIOMI 290 and 291. Recommended prerequisites: BIOMI 408, BIOBM 330–332, BIOBM 432. Lecs, T R 2:30–3:20. Offered alternate even years. G. Whittaker.
This course is complementary to BIOMI 408, Viruses and Disease I, but is complete in its own right. As such, completion of BIOMI 408 is not a requirement. The structure and classification of viruses, virus entry, genome replication and assembly are studied with particular emphasis on virus-host cell interactions. Vaccination, chemotherapy and evolution of viruses are also discussed.

BIOMI 414 Bacterial Diversity
Spring. 3 credits. Prerequisites: BIOMI 290, and 291, BIOBM 330 or 331 or 333 recommended. Lecs, M W F 11:15. Offered alternate odd years. S. H. Zinder.
A consideration of the evolutionary biology, physiology, ecology, genetics, and practical potential of important groups of bacteria. Topics include molecular methods for

determining bacterial phylogeny, the evolution of diverse mechanisms of energy conservation, fixation of carbon and nitrogen, and adaptation to extreme environments.

[BIOMI 416 Bacterial Physiology
Spring. 3 credits. Prerequisites: BIOMI 290, 291, and BIOBM 330 or 331, or their equivalents. Lecs, M W F 11:00. Offered alternate even years. J. P. Shapleigh.
The focus of the course is on physiological and metabolic functions of bacteria. Consideration is given to chemical structure, regulation, growth, and energy metabolism. Special attention is given to those aspects of bacterial metabolism not normally studied in biochemistry courses.]

BIOMI 417 Medical Parasitology (also VETMI 431)
Fall. 2 credits. Prerequisites: courses pertaining to zoology and biology. Lecs, T R 3:35–4:25. D. Bowman.
A systematic study of anthropod, protozoan, and helminth parasites of public health importance with emphasis on epidemiologic, clinical, and zoonotic aspects of these parasitisms.

BIOMI 418 Microbial Ecology
Spring. 3 credits. Prerequisites: BIOMI 290 and 291, or BIOMI 398 and instructor's permission, and BIOBM 330 or 331 and 332. Lecs, M W F 10:10–11:00. E. R. Angert.
Understanding the role of microorganisms in natural environments is one of the greatest challenges facing microbiologists. This course introduces current biochemical and macromolecule sequence-based methods to assess community diversity and microbial activity in a variety of ecosystems. Other topics discussed include bacterial growth and survival, population biology, and microbial interactions.

BIOMI 420 Microbial Genomics
Spring. 2 credits. Prerequisites: BIOMI 290, BIO G 281, BIOBM 330, or equivalent. Lecs, T R 10:10–11:00. Offered alternate odd years. J. P. Shapleigh and J. D. Helmann.
Genomic information is revolutionizing biology. We discuss the impact of genomic information on the study of microbial physiology, evolution, and biotechnology. Topics include both techniques (automated DNA sequencing, assembly, annotation, DNA chips) and applications (genome-wide analysis of transcription, functional genomics).

BIOMI 485 Bacterial Genetics (also BIOGD 485)
Fall. 2 credits. Graduate students, see BIOMI 685. Prerequisite: BIOGD 281. Recommended: BIOMI 290 and BIOBM 330 or 331 and 332 or 333. Lecs, W 7:30–9:25 p.m. Staff.
Concepts and principles of formal genetic analysis as applied to prokaryotes, with emphasis on enterobacteria and their viruses. Topics include mutagenesis and isolation of mutants; genetic exchange, recombination and mapping; complementation, epistasis and suppression; transposons; gene expression and regulation; and genetics of bacterial pathogenesis.

BIOMI 610 Introduction to Chemical and Environmental Toxicology (also TOX 610)
Fall. 3 credits. Prerequisite: graduate standing in the field or consent of the instructor. Letter grades. Lec, M W F 11:15–12:05. A. Hay.
Introduction to the general principles of toxicology including the sources, mechanisms, and targets of toxic agents. Special attention is given to the interaction between toxic agents and biological systems at both the organismal and ecological level. The effects of both anthropogenic and natural toxins are examined with respect to genetic and developmental toxicity as well as carcinogenesis and specific organ toxicity.

[BIOMI 652 (Section 02) Molecular Plant-Microbe Interactions (also BIOPL 652, Sec 02, PL PA 664)
Spring. 1 credit. Prerequisites: BIOGD 281, BIOBM 330 or 331 or 333, and BIOPL 653 (section 01) or their equivalents. S-U grades optional. Lecs, M W F 12:20 (12 lecs) Jan. 21-Feb. 15. Offered alternate even years. Not offered 2002–2003. S. C. Winans.
For course description, see BIOPL 652, Sec 02.]

BIOMI 690 Prokaryotic Biology
Fall and spring. 4 weeks/8 lectures. 1 credit/section to be offered. T R 10:15–11:30.

Section 1—Microbial Structure and Function
Fall. J. P. Shapleigh.
Discussion of those macromolecules and assemblages of macromolecules that together define the structure of the prokaryotic cell. This includes external structures, such as cell wall, flagella, pili, and peptidoglycan and internal structures such as specialized vesicles and other large complexes.

Section 2—Microbial Genetics
Fall. J. D. Helmann.
Reviews the fundamental concepts of microbial genetics including mutations and their analysis, plasmids, conjugation, transformation, transduction, transposition, recombination, repair, and mutagenesis.

Section 3—Microbial Physiology/Diversity
Fall. S. H. Zinder.
The major energy conserving modes of metabolism and their phylogenetic distributions among both bacteria and archaea are reviewed. Topics include phylogenetic analysis fermentation, respiration, photosynthesis, and pathways of carbon and nitrogen fixation, and evolution of the three domains of life.

Section 4—Microbial Pathogenesis
Spring. S. C. Winans.
An introduction to the fundamental concepts of bacterial pathogenesis including the normal flora, pathogen entry and colonization, the production and regulation of toxins, horizontal transfer of pathogenesis determinants, and the roles of both specific and nonspecific host defenses. Examples will include bacterial pathogens of both animals and plants.

Section 5—Environmental Microbiology
Spring. E. L. Madsen.
A core course of concepts, methods, and current literature that reveals the multidisciplinary nature of environmental microbiology and its relationship to prokaryotic biology. The crucial roles that microorganisms play in catalyzing biogeochemical reactions throughout the biosphere will be discussed.

BIOMI 791 Advanced Topics in Microbiology
Fall or spring. 1 credit. May be repeated for credit. Prerequisite: graduate standing in microbiology. S-U grades only. Sec 01 Bacterial Genetics, T 4:00–5:00, S. C. Winans; Sec 02 Environmental Microbiology, W 4:00–5:00, E. R. Angert.
Reading and presentation by graduate students of current literature in selected areas of modern microbiology.

BIOMI 795–796 Current Topics in Microbiology
Fall, 795; spring, 796. 1/2 or 1 credit for each topic. May be repeated for credit. Designed primarily for graduate students in microbiology. Prerequisite: upper-level courses in microbiology. S-U grades only. Lecs TBA. Staff.
Lectures and seminars on special topics in microbiology.

BIOMI 797 Scientific Communication Skills
Fall and spring. 1 credit each semester. F 2:30–3:20. Staff.
The ability to communicate effectively is essential for success as a scientist. The primary goal of this course is to provide students with an opportunity to develop self-confidence and refine their formal oral presentation skills. Students are asked to present topical seminars that will be critically evaluated by the instructor. Feedback for improving the presentation and peer evaluations will be emphasized. Taken by students in the Graduate Field of Microbiology during their first two semesters, a third semester is optional.

BIOMI 798 Graduate Research Seminar in Microbiology
Fall and spring. 1 credit each semester. Required of all graduate students in the Graduate Field of Microbiology. S-U grades only. F 1:25–2:15. Staff.
All graduate students in the Field of Microbiology are required to attend BIOMI 798 and are required to present a seminar concerning their research at least once each year.

BIOMI 799 Microbiology Seminar
Fall and spring. Required of all graduate students in the Graduate Field of Microbiology and open to all who are interested. Sem R 4–5. Staff.

Related Courses in Other Departments

Advanced Food Microbiology (Food Science 607)

Advanced Immunology Lectures (Biological Sciences [BIO G] 705 and Veterinary Microbiology 705)

Advanced Work in Bacteriology, Virology, or Immunology (Veterinary Microbiology 707)

Bacterial Plant Diseases (Plant Pathology 647)

Basic Immunology, Lectures (Biological Sciences [BIO G] 305 and Veterinary Microbiology 315)

Ecology of Soil-Borne Pathogens (Plant Pathology 644)

Food Microbiology, Laboratory (Food Science 395)

Food Microbiology, Lectures (Food Science 394)

Immunology of Infectious Diseases and Tumors (Biological Sciences [BIO G] 706 and Veterinary Microbiology 719)

Introduction to Scanning Electron Microscopy (Biological Sciences [BIO G] 401)

Introductory Mycology (Plant Pathology 309)

Light and Video Microscopy for Biologists (Biological Sciences [BIO G] 450)

Limnology: Ecology of Lakes, Lectures (Biological Sciences [BIOEE] 457)

Magical Mushrooms, Mischievous Molds (Plant Pathology 201)

Microbiology for Environmental Engineering (Civil and Environmental Engineering 451)

Plant Virology (Plant Pathology 645)

Principles of Biogeochemistry (Biological Sciences [BIOEE] 668)

The Soil Ecosystem (Crop and Soil Science 366)

NEUROBIOLOGY AND BEHAVIOR (BIONB)

[BIONB 111 Brain Mind and Behavior (also PSYCH 111 and COGST 111)
Spring. 3 credits. Intended for freshmen and sophomores in the humanities and social sciences; junior non-biology majors by permission only. Letter grades only. Lecs, M W F 9:05. Not offered 2002–2003. E. Adkins Regan and R. R. Hoy.
See COGST 111 for description.]

BIONB 221 Neurobiology and Behavior I: Introduction to Behavior
Fall. 3, 4, or 5 credits (4 credits with one discussion per week; 5 credits with two discussions per week and participation in the Writing in the Majors program). 4- or 5-credit option required of students in the neurobiology and behavior program of study. Each 4-credit discussion section is limited to 20 students, with preference given to students studying neurobiology and behavior. Enrollment in the 5-credit option is limited to 12 students. Students may not preregister for the 5-credit option; interested students complete an application form on the first day of class. Not open to freshmen. Prerequisite: 1 year of introductory biology for majors. May be taken independently of BIONB 222. S-U grades optional. Lecs, M W F 12:20, disc TBA. H. K. Reeve and staff.
A general introduction to the field of behavior. Topics include evolution and behavior, behavioral ecology, sociobiology, chemical ecology, communication, rhythmicity, orientation and navigation, and hormonal mechanisms of behavior.

[BIONB 221 Neurobiology and Behavior 1: Introduction to Behavior
Summer. 3 or 4 credits (4 credits with one discussion per week). Prerequisite: 1 year of introductory college biology. S-U grades optional. Course fee: none. Six week session. M-F. 4:00–5:15 p.m. Staff.
A general introduction to the field of behavior. Topics include evolution and behavior, behavioral ecology, sociobiology, chemical ecology, communication, rhythmicity, orientation and navigation, and hormonal mechanisms of behavior.]

BIONB 222 Neurobiology and Behavior II: Introduction to Neurobiology
Spring. 3 or 4 credits (4 credits with discussion and written projects). 4-credit option required of students studying neurobiology and behavior. Each discussion limited to 20 students, with preference given to students studying neurobiology and behavior. Not open to freshmen. Prerequisites: 1 year of introductory biology for majors and 1 year of chemistry. May be taken independently of BIONB 221. S-U grades optional. Lecs, M W F 12:20; disc TBA. A. Bass and staff.
A general introduction to the field of cellular and integrative neurobiology. Topics include neural systems, neuroanatomy, developmental neurobiology, electrical properties of nerve cells, synaptic mechanisms, neurochemistry, motor systems, sensory systems, learning, and memory. Some discussion sections include dissections of preserved brains.

BIONB 322 Hormones and Behavior (also PSYCH 322)
Fall. 3 credits; 2 lectures plus a section in which students read and discuss original papers in the field, give an oral presentation, and write a term paper. Limited to juniors and seniors. Prerequisite (1 of the following): PSYCH 223, or BIONB 221, or BIONB 222, or one year of introductory biology plus a course in psychology. Letter grades only. Lec M W F 11:15. E. Adkins Regan.
See PSYCH 322 for description.

BIONB 323 Methods in Animal Behavior
Fall. 4 credits. Prerequisites: BIONB 221, a statistics course, and permission of instructor (must fill out an application available in W363 Mudd Hall). Letter grades only. Lec, M W 1:25–2:15; labs M W 2:15–4:25. Offered alternate years. S. Vehrencamp and J. Bradbury.
Covers methods for observing and quantifying behavioral interactions and communication signals. Lectures and a series of exercises and experiments designed to introduce students to commonly used field and laboratory methods. Emphasis is on experimental design and basic statistical techniques. Some lab work with live insects included. Additional lab time often needed to complete experiments.

BIONB 324 Biopsychology Laboratory (also PSYCH 324)
Fall. 4 credits. Limited to 20 upperclass students. Prerequisites: laboratory experience in biology or psychology, BIONB 221 and 222 or PSYCH 123 and 222; and permission of instructor. Labs, T R 1:25–4:25. T. DeVoogd.
See PSYCH 324 for description.

BIONB 325 Neurodiseases—Molecular Aspects
Fall. 3 credits. Prerequisites: two courses from BIONB 222, BIOGD 281, BIOBM 330, or 331; co-registration in one of the two is acceptable. S-U grades optional. Lecs, T R 9:05; disc, T 1:25, 2:30, or 3:35. T. R. Podleski.
The intent of this course is to teach students how to use recombinant DNA techniques for the study of neurodiseases. How are genes responsible for diseases identified and how are the functions of these genes studied? Attention is focused on those neural diseases in which significant advances have been made using these techniques, for example, Alzheimer's, Huntington's, Prion diseases, schizophrenia, depression, disorders affecting ion channels, and muscular dystrophies. Emphasis is placed on how these studies provide a useful approach to studying the mammalian nervous system by exposing the functions of genes that would be difficult to identify in other ways.

[BIONB 326 The Visual System
Spring. 4 credits. Prerequisite: BIONB 222 or BIOAP 311, or permission of instructor. S-U grades optional. Lecs, M W F 10:10; disc, 1 hour each week TBA. Offered alternate years. Not offered 2002–2003. H. C. Howland.
The visual systems of vertebrates are discussed in breadth and depth as well as some aspects of invertebrate vision. Topics covered include the optics and anatomy of eyes, retinal neurophysiology, structure and function of higher visual centers, ocular motility and ocular and visual system development.]

BIONB 327 Evolutionary Perspectives on Human Behavior
Fall. 3 credits. Prerequisites: BIONB 221 and permission of instructor required. Letter grades only. T R 2:55–4:10. S. T. Emlen.
A Socratically taught, discussion-based course dealing with evolutionary perspectives on human behavior. Topics include genes and behavior, the evolutionary environment of adaptation, the evolutionary function of emotions, human mating system, parenting strategies, and cooperation and conflict within family-based societies. All class members read and discuss primary papers and recent books. Each student is responsible for leading multiple discussions, for writing an original paper, and for peer-reviewing papers of other class members.

BIONB 328 Biopsychology of Learning and Memory (also PSYCH 332)
Spring. 3 credits. Prerequisites: 1 year of biology and either a course in biopsychology or BIONB 222. S-U grades optional. Lecs, M W F 11:15. T. DeVoogd.
See PSYCH 332 for description.

BIONB 329 Ecology of Animal Behavior (also BIOSM 329)
Summer. 4 credits. Prerequisite: 1 year of introductory college biology. Recommended: course work in ecology, psychology, or behavior. S-U grades optional. A special 2-week course offered at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Daily lecs, labs, and fieldwork for 2 weeks. SML faculty.
See BIOSM 329 for description.

BIONB 330 Introduction to Computational Neuroscience (also PSYCH 330 and COGST 330)
Fall. 3 credits. Limited to 25 students. Prerequisites: BIONB 222 or permission of instructor. S-U grades optional. Lecs, T R 2:55–4:10. Offered alternate years. C. Linster.
This course covers the basic ideas and techniques involved in computational neuroscience. The course surveys diverse topics including: neural dynamics of small networks of cells, neural coding, learning in neural networks and in brain structures, memory models of the hippocampus, sensory coding, and others.

[BIONB 392 Drugs and the Brain
Spring. 4 credits. Prerequisites: BIONB 222 or equivalent course in neurobiology with permission of instructor. A knowledge of biochemistry is useful but not required. S-U grades optional. T R 10:10–11:25; disc TBA. Offered alternate years. Not offered 2002–2003. R. Harris-Warrick.
An introduction to neuropharmacology, with an emphasis on the neural mechanisms of psychoactive drugs. Topics include a brief introduction to neuropharmacology and a discussion of the major neurotransmitter families. The rest of the course covers the major psychoactive drugs, including cocaine, heroin, psychedelics, marijuana and alcohol, as well as pharmaceuticals for the treatment of anxiety, schizophrenia and depression. The course includes a term paper in the form of a grant proposal to study a current problem in neuropharmacology.]

[BIONB 394 Circadian Rhythms (also BIOGD 394 and ENTOM 394)
Fall. 2 credits. Prerequisite: ENTOM 212, or BIOGD 281, or BIONB 221 or 222, or permission of instructor. S-U grades optional. Lec, W 7:30–9:10 p.m. Offered alternate years. Not offered 2002–2003. J. Ewer.
For description, see ENTOM 394.]

[BIONB 396 Introduction to Sensory Systems (also PSYCH 396 and 696)
Spring. 4 credits. Limited to 25 students. Prerequisites: an introductory course in biology or biopsychology, plus a second course in behavior, biopsychology, cognitive science, neuroscience, or perception. Students are expected to have knowledge of elementary physics, chemistry, and behavior. S-U grades optional. Lecs, M W F 10:10. Offered alternate years. Not offered 2002–2003. B. P. Halpern.
See PSYCH 396 for description.]

BIONB 420 Topics in Neurobiology and Behavior
Fall or spring. Variable credit. May be repeated for credit. Primarily for undergraduates. S-U grades optional. TBA. Staff.
Courses on selected topics in neurobiology and behavior; can include lecture and seminar courses. Topics, instructors, and time of organizational meetings are listed in the catalog supplement issued at the beginning of the semester.

BIONB 421 Effects of Aging on Sensory and Perceptual Systems (also PSYCH 431 and 631)
Fall. 3 or 4 credits. The 4-credit option involves a term paper or creation of a relevant web site. Limited to 25 students. Prerequisites: an introductory course in biology or psychology, plus a second course in perception or neurobiology or cognitive science or biopsychology. T R 10:10–11:25. B. P. Halpern.
For description see PSYCH 431.

[BIONB 422 Modeling Behavioral Evolution
Spring. 4 credits. Limited to 25 students. Prerequisites: BIONB 221, 1 year of calculus, 1 course in probability or statistics, and *permission of instructor* (Office: W309 Mudd Hall; phone: 254–4352). This course is open to advanced undergraduates and graduate students. S-U grades optional. Lecs, T R 2:55–4:10; computer lab, 1 class period per week TBA. Offered alternate years. Not offered 2002–2003. H. K. Reeve.
This is an intensive lecture and computer lab course on modeling strategies and techniques in the study of behavioral evolution. Population-genetic (including quantitative-genetic), static optimization, dynamic programming, and game-theoretic methods are emphasized. These approaches are illustrated by application to problems in optimal foraging, sexual selection, sex ratio evolution, animal communication, and the evolution of cooperation and conflict within animal social groups. Students learn to assess critically recent evolutionary theories of animal behavior, as well as to develop their own testable models for biological systems of interest or to extend pre-existing models in novel directions. The *Mathematica* software program is used as a modeling tool in the accompanying computer lab (no prior experience with computers required).]

[BIONB 424 Neuroethology (also PSYCH 424)
Spring. 4 credits. Prerequisites: BIONB 221 or 222, or 1 year of introductory biology for majors and permission of instructor. S-U grades optional. M W F 11:15; disc, 1 hour each week TBA. Offered alternate years. Not offered 2002–2003. C. D. Hopkins.
Neuroethologists take a comparative and evolutionary approach to study the nervous system. They ask, how do brains of animals compare and how did they come about through the process of evolution? How are neural circuits adapted to species-typical behavior? What is the hope and interest in the study of a large diversity of animals, compared to a specialized look at just a few mammalian species? Can we hope to understand how animals with specialized behaviors have specialized nervous systems? What is the sensory world of a real animal and how does it vary from species to species? These and other questions derive this introductory survey of neuroethology including: exotic senses; amazing motor programs; surprising integration.]

BIONB 425 Molecular Neurophysiology
Spring. 3 credits. Prerequisite: BIONB 222 or permission of instructor. S-U grades optional. Lecs, T R 2:55–4:10. Offered alternate years. D. McCobb.
Course focuses on ion channels, the primary proteins generating cellular electrical signals function in nerve cells and other excitable cells (e.g., muscle, heart, glands). The latest electrophysiological and molecular genetic experiments are reviewed. Diversity of electrophysiology deriving from channel structure and expression patterns is considered in the contexts of behavior and behavioral plasticity (learning), neural development, and channel evolution. Course format includes written and oral presentations, reviewing scientific literature in selected areas, and proposing new experiments.

[BIONB 426 Animal Communication
Spring. 4 credits. Prerequisites: BIONB 221. Letter grade only. T R 2:55–4:10; disc, 1 hour each week TBA. Offered alternate years. Not offered 2002–2003. J. Bradbury, S. Vehrencamp.
An integrated approach to animal communication, organized into three parts: 1) the physics and physiology of producing, transmitting, and receiving signals; 2) optimal strategies for encoding information, using information to make decisions, and designing signals; and 3) the behavioral ecology of signal evolution.]

[BIONB 427 Animal Social Behavior
Fall. 4 credits. Limited to 30 students. Prerequisites: BIONB 221 and BIOEE 261 or 278, and advance permission of instructor. S-U grades optional, with permission of instructor. Lecs and discs, M W 2:55–4:10. Offered alternate years. Not offered 2002–2003. T. D. Seeley.
An intensive course for upper-division students interested in behavorial ecology and sociobiology. Lectures, discussions, and student presentations examine topics including adaptation, communication, mating systems, sexual selection, sex ratios, inbreeding and outbreeding, altruism, kin recognition, and conflict and cooperation in animal societies.]

[BIONB 429 Olfaction and Taste: Structure and Function (also PSYCH 429)
Spring. 3 or 4 credits (4 credits with term paper or research project, which can, but need not, study nonhuman vertebrates). Preference given to junior and senior psychology and biology majors and graduate students. Graduate students, see PSYCH 629. Prerequisite: a 300-level course in biopsychology or equivalent. Lecs, T R 9:05. Offered alternate years. Not offered 2002–2003. B. P. Halpern.
See PSYCH 429 for description.]

BIONB 430 Experimental Molecular Neurobiology (also BIOBM 443)
Spring. 2 credits variable. Limited to 12 students. Prerequisites: co-meeting with BIOBM 430 lab. Mandatory registration via web page: www.mbg.cornell.edu/courses.html. Letter grade only. Disc, 1 hour each week on day other than lab day; Lab T or R all day, or M and W afternoons, to be coordinated with other BIOBM 430 sections. Offered alternate years. D. L. Deitcher.
See BIOBM 443 for description.

[BIONB 440 Electronics in Neurobiology
Fall. 4 credits. Limited to juniors, seniors, and graduate students. Prerequisites: a calculus course. S-U grades optional. Lecs, T R 8:40–9:55; lab, W 1:25–4:25. Offered alternate years. Not offered 2002–2003. B. R. Land.
The course emphasizes understanding of the electrical functioning of the nervous system and enables students to build instrumentation to study the nervous system. It is taught by mathematical analysis, simulation, and construction of circuit examples drawn from practical neurobiological instrumentation problems and the electronic basis of neurons.]

BIONB 441 Computers in Neurobiology
Fall. 4 credits. Limited to juniors, seniors, and graduate students. Prerequisites: a calculus course. S-U grades optional. Lecs, T R 8:40–9:55; lab, W 1:25–4:25. Offered alternate years. B. R. Land.
This course is an introduction to computer instrumentation techniques and data reduction. It gives a basic understanding of the techniques used for coupling a biological experiment to a computer. It includes techniques to convert raw data to scientific visualization. Some computer modeling examples drawn from practical neurobiological problems are done.

BIONB 470 Biophysical Methods (also A&EP 470 and VETPR 470)
Spring. 3 credits. Prerequisites: basic knowledge of and interest in physics and mathematics is expected, but strong efforts are made to give an intuitive understanding of the mathematics and physics involved. Some knowledge of physical chemistry, molecular and cell biology, or neurobiology will be helpful. Depending on individual background, all students will find certain aspects easy and other aspects demanding. Letter grades only. Lecs, T R 8:40–9:55. M. Lindau.
See A&EP 470 for description.

BIONB 491 Principles of Neurophysiology
Spring. 4 credits. Limited to 20 students. Prerequisite: BIONB 222 or written permission of instructor. S-U grades optional for graduate students with permission of instructor. Lecs, M W 10:10; lab, M or T 12:20–4:25; additional hours TBA. B. R. Johnson.
A laboratory-oriented course designed to teach the theory and techniques of modern cellular neurophysiology including computer acquisition and analysis of laboratory results. Lecture time is used to introduce laboratory exercises and discuss results, to supplement laboratory topics, and for discussion of primary research papers. Extracellular and intracellular recording and voltage clamp techniques are used to analyze motor neuron and sensory receptor firing properties, and examine the cellular basis for resting and action potentials and synaptic transmission. Invertebrate preparations are used as model systems. (See course web site: http://www.nbb.cornell.edu/neurobio/bionb491/bionb491.html)

BIONB 492 Sensory Function (also PSYCH 492 and 692)
Spring. 4 credits. Limited to 25 students. Prerequisite: a 300-level course in biopsychology, or BIONB 222, or BIOAP 311, or equivalent. Students are expected to have knowledge of elementary physics, chemistry, and behavior. S-U grades optional. Lecs, M W F 10:10. Offered alternate years. H. C. Howland, B. P. Halpern.
See PSYCH 492 for description.

BIONB 493 Developmental Neurobiology
Fall. 3 credits. Prerequisite: BIONB 222 or permission of instructor. S-U grades optional, with permission of instructor. Lecs, M W 2:55–4:10. Offered alternate years. R. Booker.
Lectures covering the development of the nervous system, taking examples from both vertebrates and invertebrates. Emphasis is on cellular and molecular issues, that is, how do nerve cells differentiate both morphologically and biochemically? The role of cues such as hormones and developmental genes in neural development is discussed. Readings are taken from original journal articles.

BIONB 494 Brain Evolution and Behavior
Spring. 3 credits. Intended for juniors, seniors, and graduate students. Prerequisite: BIONB 222 or equivalent. S-U grades optional. Lecs, T R TBA. Offered alternate years. A. H. Bass.
Organization and evolution of neuroanatomical pathways as substrates for species-typical vertebrate behaviors. The course is divided into three major sections: development, general principles of brain organization, and co-evolution of vertebrate brain and behavior.

BIONB 495 Molecular and Genetic Approaches to Neuroscience
Fall. 3 credits. Limited to juniors, seniors, and graduate students. Prerequisites: BIONB 222 and BIOBM 330 or 332. Letter grade only. Lecs, T R 2:55–4:10. Offered alternate years. D. Deitcher.
Focus of the course is on how different molecular and genetic approaches have led to major advances in neuroscience. Lectures, student presentations, and discussions examine original research articles. Topics include ligand-gated channels, potassium channels, seven membrane spanning receptors, development of the neuromuscular junction, neurotransmitter release, second messengers, and learning and memory.

[BIONB 496 Bioacoustic Signals in Animals and Man
Spring. 3 credits. Limited to 12 junior, senior, and graduate students. Prerequisites: 1 year of introductory biology, PHYS 101–102 or 207–208, and permission of instructor. S-U grades optional. Lecs, M W 9:05; lab TBA. Offered alternate years. Not offered 2002–2003. C. W. Clark.
Humans and animals live in a world of sound. Mechanisms for sound production and perception are extremely varied. Acoustic signals mediate social interactions, and are used to scan the environment for food and to aid in navigation. For many species acoustic sensing plays a critical role in predator detection and avoidance. This course teaches students about animal acoustic signaling by introducing them to various animal acoustic systems. The course presents the physical properties of sound, physiological mechanisms for sound production and hearing, and the behavioral contexts in which sounds are used. Acoustic techniques are provided in the laboratory where students learn how to record, synthesize, and analyze sounds with the aid of recorders and Mac and/or PC computers running customized software. Labs are designed around the lecture material and provide practical "real-world" exercises designed to stimulate discovery of fundamental principles described in lectures. Class research projects on a selected topic in bioacoustics are required. Engineering students with interests in music, audio analysis, and digital signal processing are encouraged.]

BIONB 531 Representation of Structure in Vision and Language (also COGST 531, LING 531, PSYCH 531, COM S 531)
Spring. 4 credits. Prerequisites: COGST 101. S-U grades optional. M 4:15–6:15 p.m. S. Edelman.
See COGST 531 for description.

[BIONB 623 Chemical Communication (also CHEM 622)
Fall. 3 credits. Primarily for research-oriented students. Limited to 30 students. Prerequisites: 1 year of introductory biology for majors or equivalent, course work in biochemistry, and CHEM 358 or equivalent. S-U grades optional. Lecs, M W 10:10; disc, F 10:10. Offered alternate years. Not offered 2002–2003. T. Eisner, J. Meinwald, W. L. Roelofs, and guest lecturers.
The production, transmission, and reception of chemical signals in communicative interactions of animals, plants, and microorganisms. Studies of insects are emphasized. Specific topics are treated with varying emphasis on chemical, biochemical, ecological, behavioral, and evolutionary principles.]

BIONB 720 Seminar in Advanced Topics in Neurobiology and Behavior
Fall or spring. Variable credit. May be repeated for credit. Primarily for graduate students; written permission of instructor required for undergraduates. S-U grades optional. Sem TBA. Staff and students.
Designed to provide several study groups each semester on specialized topics. A group may meet for whatever period is judged adequate to enable coverage of the selected topics. Ordinarily, topics are selected and circulated during the preceding semester. Discussion of current literature is encouraged. Suggestions for topics should be submitted by faculty or students to the chair of the Department of Neurobiology and Behavior.

BIONB 721 Introductory Graduate Survey in Neurobiology and Behavior
Fall. 2 credits. Required of graduate students majoring in neurobiology and behavior. Concurrent registration in BIONB 221 and 222 not required. S-U grades only. Lecs and discs, TBA. H. K. Reeve and staff.
Lectures, readings, and discussion introduce first-year graduate students to the research activities of the faculty in the Graduate Field of Neurobiology and Behavior. Class meets weekly for two hours. Students also prepare a research proposal on a potential topic for their thesis research (in the format of an NSF or NIH grant). This proposal is prepared in consultation with one or more relevant faculty members.

Related Courses in Other Departments

Evolutionary Perspectives on Behavior (PSYCH 535)

Biopsychology of Normal and Abnormal Behavior (PSYCH 361 and NS 361)

Cognitive Neuroscience (PSYCH 425)

Developmental Biopsychology (PSYCH 422)

Evolution of Human Behavior (PSYCH 326)

Insect Behavior Seminar (ENTOM 662)

Topics on Primates and Evolution: The Evolution of Language (ANTHR 490)

Primate Behavior and Ecology (ANTHR 390)

Teaching Experience (Biological Sciences [BIO G] 498)

The Brain and Sleep (PSYCH 440/640)

Undergraduate Research in Biology (Biological Sciences [BIO G] 499)

OTS Undergraduate Semester Abroad Programs

Shoals Marine Laboratory Program

PLANT BIOLOGY (BIOPL)

[BIOPL 240 Green World/Blue Planet
Spring. 3 credits. S-U grades optional. Lecs, T R 1:25–2:40. Not offered 2002–2003. K. J. Niklas, E. R. Turgeon, T. G. Owens.
This course focuses on helping individuals understand how scientific information relates to the issues they face as citizens, in management decision making, and in public policy. To what extent should genetic engineering of

crop plants be permitted? Should we place limits on fossil fuel consumption as a means of limiting global warming and global climate change? Must human endeavors be restricted in certain areas to maintain diversity? The format of this course is interactive, with lectures and discussions about how we as a society deal with controversial issues.]

BIOPL 241 Introductory Botany
Fall. 3 credits. Lecs, T R 9:05; lab, M T W or R 1:25–4:25, or M W 7:30–10:30 p.m. K. J. Niklas.
Introductory botany for those interested in the plant sciences. Emphasizes structure, reproduction, and classification of angiosperms and the history of life on earth. Laboratory emphasizes development of skills in handling plant materials, including identification. First and second weeks of laboratory are field trips, starting with the first day of classes. *Those who register for an evening laboratory are still required to attend the afternoon field trips.*

BIOPL 242 Plant Function and Growth
Spring. 3 credits. S-U grades optional. Primarily for undergraduates in agricultural sciences, but also for any biological sciences students wanting to know about plant function. Suitable as a second-level course for nonmajors to satisfy the biology distribution requirement. Prerequisites: 1 year of introductory biology and/or BIOPL 241. Recommended: 1 year of introductory chemistry. Concurrent enrollment in BIOPL 244 required of plant science undergraduates and highly recommended for other science majors. May not be taken for credit after BIOPL 342 except by written permission of instructor. Evening prelims Feb. 20 and March 27. Lecs, M W F 10:10. P. J. Davies.
How plants function and grow. Examples deal with crop plants or higher plants where possible, though not exclusively. Topics include cell structure and function; plant metabolism, including photosynthesis; light relations in crops; plant-water relations; water uptake, transport, and transpiration; irrigation of crops; sugar transport; mineral nutrition; growth and development—hormones, responses to light, flowering, fruiting, dormancy, and abscission; stress; tissue culture; and genetic engineering of plants.

BIOPL 243 Taxonomy of Cultivated Plants (also HORT 243)
Fall. 4 credits. Prerequisite: 1 year of introductory biology or written permission of instructor. May not be taken for credit after BIOPL 248. Lecs, M W F 10:10; labs, M or W 2:00–4:25. Offered alternate years. M. A. Luckow.
A study of ferns and seed plants, their relationships, and their classification into families and genera, emphasizing cultivated plants. Particular emphasis is placed on gaining proficiency in identifying and distinguishing families and in preparing and using analytic keys. Attention is also given to the economic importance of taxa, to the basic taxonomic literature, and to the elements of nomenclature.

BIOPL 244 Plant Function and Growth, Laboratory
Spring. 2 credits. Prerequisite: concurrent enrollment in BIOPL 242. May not be taken for credit after BIOPL 344. Disc and lab, M T or W 12:20–4:25. T. Silva.
Experiments exemplify concepts covered in BIOPL 242 and offer experience in a variety of biological and biochemical techniques, from the cellular to whole plant level.

BIOPL 245 Plant Biology
Summer (6–week session). 3 credits. Limited to 24 students. Lecs, M-F 11:30–12:45; labs, M W 2:00–5:00. T. Silva.
Introductory botany, including plant identification. Emphasizes structure, reproduction, and classification of flowering plants. Much of the laboratory work is conducted outdoors taking advantage of several outstanding natural areas which are available for study. Those who lack college-level biology are expected to work closely with the instructor on supplemental instructional materials.

BIOPL 247 Ethnobiology
Fall. 3 credits. S-U grades optional. Lecs, T R 11:15; disc, R 12:20–1:25 or F 12:20. D. M. Bates.
A consideration of the principles, methods, and issues of ethnobiology. Emphasis is on the past and present ecological, evolutionary, economic, and cultural interrelationships of humans in traditional and lay societies with their plants and animals, as a means of understanding the place and future of humans in the biosphere. Traditional medicines, underutilized organisms, resource management, and ownership of nature, and methodology are among the topics covered.

[BIOPL 248 Taxonomy of Vascular Plants
Spring. 4 credits. Prerequisite: 1 year of introductory biology. May not be taken for credit after BIOPL 243. S-U grades optional. Lecs, M W F 9:05; lab, W or R 1:25–4:25. Offered alternate years. Not offered 2002–2003. J. I. Davis.
An introduction to the classification of vascular plants, with attention to the goals of taxonomy, the processes of plant evolution, and the means of analyzing evolutionary relationships among plants. The laboratory concentrates on methods of plant identification and presents an overview of vascular plant diversity, with particular attention to the flowering plants.]

BIOPL 340 Methods in Biological and Biochemical Prospecting
Spring. 2 credits. Prerequisites: Intro Biology (BIOG 101–104) required. Completion or concurrent enrollment in organic chemistry, recommended. TBA. Offered alternate years. E. Rodriguez.
Student participants learn theory and methodologies in ethnobotany, chemical ecology and zoopharmacognosy as they apply in a multidisciplinary fashion to chemical prospecting. The use of techniques in the chemistry of natural products and biological assays in the discovery of chemicals and their role in nature is described. Classical examples of drug development, from quinine to taxol, in the course of chemical prospecting are discussed. An overall medicinal purpose in chemoprospecting is emphasized, with mention of specific worldwide spread of diseases pressing for new drugs.

BIOPL 342 Plant Physiology, Lectures
Spring. 3 credits. Prerequisites: 1 year of introductory biology and either concurrent enrollment in BIOPL 344 or written permission of instructor. May not be taken for credit after BIOPL 242 unless written permission is obtained from instructor. Lecs, T R 10:10–11:25. T. G. Owens.
An integrated and interdisciplinary study of the processes that contribute to the growth, competition, and reproduction of plants. Topics include, but are not limited to, plant water relations, membrane properties and processes, photosynthesis, plant respiration, mineral and organic nutrition, stress physiology, control of growth and development, and responses to the environment. Emphasis is on the relationship between structure and function from the molecular to the whole-plant level.

BIOPL 343 Molecular Biology and Genetic Engineering of Plants
Spring. 2 credits. Prerequisite: 1 year general biology or permission of instructor. S-U grades optional. Lecs, T R 11:15. M. E. Nasrallah.
An introduction to current studies involving recombinant DNA technology and its application to the improvement of plants. The course emphasizes genetic transformation methodology, gene expression systems, and strategies for increasing productivity. The course is directed towards undergraduates who wish to become familiar with the theory and practice of plant biotechnology.

BIOPL 344 Plant Physiology, Laboratory
Spring. 2 credits. Prerequisite: concurrent enrollment in BIOPL 342. May not be taken for credit after BIOPL 244. Similar to BIOPL 244 but at a more advanced level. Lab, R 1:25–4:25; disc, R 12:20. T. Silva.
Experiments exemplify concepts covered in BIOPL 342 and offer experience in a variety of biological and biochemical techniques, from the cellular to whole plant level, with emphasis on experimental design.

[BIOPL 345 Plant Anatomy
Fall. 4 credits. Limited to 15 students. Prerequisite: 1 year of introductory biology or a semester of botany. Lecs, M W 9:05; labs, M W 2:00–4:25. Offered alternate years. Not offered 2002–2003. Staff.
A descriptive course with equal emphasis on development and mature structure. Lecture, laboratory, and reading are integrated in a study guide. The laboratory offers the opportunity to develop the practical skills required to make anatomical diagnoses and to write anatomical descriptions.]

BIOPL 347 Laboratory in Molecular Biology and Genetic Engineering of Plants
Spring. 2 credits. Limited to 24 students. Prerequisite: BIOPL 343 or permission of instructor. Concurrent enrollment is BIOPL 343 is encouraged. S-U grades optional. Lab, W 12:25–4:25. M. E. Nasrallah.
A companion to BIOPL 343 with laboratory activities that focus on the practice of plant biotechnology. Students will transfer genes to plants by a variety of methods, and will analyze their expression in the host genome by use of reporter gene assays, and by the preparation and analysis of nucleic acids.

[BIOPL 348 The Healing Forest
Spring. 2 credits. Prerequisites: introductory biology or plant biology, or permission of instructor. Lec/disc, R 2:30–4:25. Offered alternate years. Not offered 2002–2003. D. M. Bates, E. Rodriguez.
An ethnobotanical and ethnopharmacological consideration of the role of plants, fungi, and insects in traditional and western medicine. Studies of indigenous and lay societies illustrate the ecological, systematic, biochemi-

cal, and cultural aspects of herbal medicines and are placed in the broader context of such interdependent themes as the conservation of biological and cultural diversity, human health, bioprospecting, compensation for indigenous knowledge, and sustainable development.]

BIOPL 359 Biology of Grasses
Spring. 2 credits. Prerequisite: 1 year of introductory biology or a course in plant systematics or permission of instructor. S-U grades optional. Lecs, W 9:05; lab, W 1:25–4:25. Offered alternate years. J. I. Davis.
Systematics and related aspects of the biology of the graminoid plant families (grasses, sedges, and rushes), with the principal emphasis on grasses. Major topics include phylogenetics, taxonomy, physiology, reproductive biology, speciation, and biogeography. The roles of graminoid plants in natural and human-disturbed environments are discussed, as are the origins of cultivated species.

BIOPL 404 Crop Evolution, Domestication and Diversity (also PL BR 404, INTAG 404)
Spring. 2 credits. S-U letter. Prerequisites: Genetics 281 or Plant Breeding 225 or permission of the instructor. Lecs, T R 9:05. S. Kresovich.
See PL BR 404, for description.

BIOPL 440 Phylogenetic Systematics
Spring. 4 credits. Limited to 24 students. Prerequisite: introductory biology or permission of instructor. Lecs, T R 10:10; labs, T R 2:00–4:25. Offered alternate years. K. C. Nixon.
Basic and advanced theory and methods of phylogenetic analysis. Students are introduced to cladistic analysis using parsimony and gain experience with computer-aided analysis of taxonomic data, including both morphological and molecular data sources. Topics discussed include applications of phylogenetic methods to biogeography and evolutionary studies.

[BIOPL 442 Current Topics in Ethnobiology
Fall. 2 or 4 credits (4 credits with an independent research component and term paper). Prerequisites: BIOPL 247, 348, or permission of instructor. Lec/disc, T 2:30–4:25. Offered alternate years. Not offered 2002–2003. D. M. Bates.
Explorations of the interrelationships of plants and animals with humans from a wide range of perspectives. Topics considered are contemporary issues, theory, and methodology of ethnobotany and ethnobiology, and the role of plants and animals in human lives, in subsistence and exchange, and in thought.]

BIOPL 443 Topics and Research Methods in Systematics
Fall or spring. 1–2 credits (1 credit per section). Prerequisite: written permission of instructor. S-U grades optional. Staff.
A series of one-credit modules on specialized topics in systematics. Topics and instructors vary each semester. May not be taught every semester. Topics and instructors are listed in the division's catalog supplement issued at the beginning of the semester.

BIOPL 444 Plant Cell Biology
Fall. 4 credits. Limited to 24 students. Prerequisites: 1 year of introductory biology or permission of instructor. Lecs, M W F 9:05; lab, M or W 1:25–4:25. R. O. Wayne.
Evidence from microscopy, physiology, biochemistry, and molecular biology is used to try to unravel the mystery of the living cell. The dynamics of protoplasm, membranes, and the various organelles are studied. The mechanisms of cell growth and division, the relationship of the cytoskeleton to cell shape and motility, the interaction of the cell with its environment, and the processes that give rise to multicellular differentiated plants are investigated.

BIOPL 445 Photosynthesis
Fall. 3 credits. Prerequisites: 1 year of college chemistry and mathematics. Recommended: 1 year of college physics and plant physiology. Lecs, M W F 10:10. Offered alternate years. T. G. Owens.
An introduction to the processes of photosynthesis in plants, algae and bacteria. An interdisciplinary approach is emphasized incorporating biochemical, biophysical, physiological and molecular perspectives. The course covers the range of processes involved in photosynthesis beginning with light harvesting and primary photochemistry through electron transport and inorganic carbon fixation. Emphasis is placed on the regulation of photosynthesis from the cellular to the whole-plant level.

[BIOPL 447 Molecular Systematics
Fall. 3 credits. Prerequisites: BIOEE 278 or BIOGD 281 or BIOBM 330, or BIOBM 332, or written permission of instructor. Lecs, T R 8:30–9:55. Offered alternate years. Not offered 2002–2003. J. J. Doyle.
The theory and practice of using molecular evidence, particularly DNA sequence data, for addressing diverse systematic and evolutionary questions. Emphasis is on phylogeny reconstruction, particularly in eukaryotic systems. The organization and evolution of nuclear and organellar genomes is described from the standpoint of their suitability for systematic and evolutionary studies.]

BIOPL 448 Plant Evolution and the Fossil Record
Spring. 3 credits. Prerequisite: BIOPL 241 or equivalent, or permission of instructor. Lecs, T R 9:05; lab, R 12:20–2:15. Offered alternate years. K. J. Niklas, W. L. Crepet.
An introduction to evolution, surveying major changes in plants from the origin of life to the present. Emphasis is placed on plant form and function, adaptations to particular ecologic settings, and evolutionary theory as it relates to plants.

[BIOPL 449 Green Signals and Triggers—The Plant Hormones (also HORT 449)
Fall. 1 credit. S-U grades optional. Prerequisite: 1 year of introductory biology and permission of instructor. F 1:25–2:15. Offered alternate years. Not offered 2002–2003. P. J. Davies.
A study of plant hormones and how they regulate plant growth and development. Topics covered include the discovery, role in growth and development, mode of action, and practical uses of the plant hormones auxin, gibberellins, cytokinins, abscisic acid, ethylene, and brassinosteroids.]

[BIOPL 452 Systematics of Tropical Plants
Spring. 3 credits. Prerequisite: BIOPL 243 or BIOPL 248. Letter grades only. Lec, M W; lab, T 1:25–4:25. Offered every three years. Not offered 2002–2003. K. C. Nixon.
The families of plants encountered solely or chiefly in tropical regions are considered in a phylogenetic context in lectures, discussions, and laboratory, with the aim of providing basic points of recognition for, and an understanding of, diversity and relationships in these families.]

[BIOPL 453 Principles and Practice of Historical Biogeography (also ENTOM 453)
Fall. 3 credits. Prerequisite: a course in systematics or permission of instructors. S-U grades optional. Lecs, T R 10:10; lab T 1:25–4:25. Offered alternate years. Not offered 2002–2003. J. K. Liebherr and M. A. Luckow.
A survey of techniques in historical biogeography, and the development of modern biogeographic theory in the context of classical, ecological, and phylogenetic analytical methods. Geological and paleontological aspects of biogeography are presented, and large-scale biogeographic patterns discussed. Laboratories focus on computer applications and discussion of controversial issues.]

[BIOPL 454 Systematics of Tropical Plants: Field Laboratory
Spring break. 1 credit. Limited to 15 students. Prerequisite: concurrent enrollment in BIOPL 452 or permission of instructor. Letter grades only. For more details and application, contact the L. H. Bailey Hortorium, 467 Mann Library. Offered every three years. Not offered 2002–2003. K. C. Nixon.
An intensive orientation to families of tropical flowering plants represented in forests of the American Tropics. Emphasis is on field identification combined with laboratory analysis of available materials in a "whole-biology" context.]

BIOPL 456 Biomechanics of Plants (also BEE 456)
Fall. 3 credits. Prerequisites: upper division undergraduate or graduate status, completion of introductory sequence in biology and one year of calculus, or permission of instructor. S-U or letter grade optional. Lecs, T R 11:15–12:05; disc, W 2:30–3:20. J. R. Cooke and K. J. Niklas.
See ABEN 456, for description.

BIOPL 462 Plant Biochemistry
Spring. 3 credits. Prerequisites: BIOPL 242 or 342 or equivalent and BIOBM 330 or 331 or equivalent or permission of instructor. Lecs, M W F 9:05. J. Rose, K. Van Wijk.
This course focuses on biochemistry of plant-specific processes, with the aim to obtain an integrative overview of plant biochemistry. Examples include processes such as cell wall biochemistry, pigment biosynthesis and degradation, secondary metabolism, senescence, defense mechanisms, amino acid biosynthesis, and small molecule transport. Genomics based experimental tools, such as proteomics and metabolomics are discussed.

BIOPL 641 Laboratory in Plant Molecular Biology (also BIOBM 641)
Fall. 4 credits. Prerequisites: BIOGD 281 or equivalent, BIOBM 330 or 331 or equivalent, and permission of instructor. S-U grades with permission of instructor. Lab, T 9:05–4:30. J. B. Nasrallah, M. R. Hanson.

Selected experiments on gene expression, gene transfer, and assay of reporter genes in plants. The course emphasizes the application of molecular biology methodology to plant systems. Additional lab time is required to complete assignments.

BIOPL 642 Plant Mineral Nutrition (also CSS [SCAS] 642)
Spring. 3 credits. Prerequisite: BIOPL 342 or equivalent. Lecs, M W F 10:10. Offered alternate years. L. V. Kochian, R. M. Welch.
A detailed study of the processes by which plants acquire and use mineral nutrients from the soil. Topics include: the uptake, translocation, and compartmentation of mineral elements; root-soil interactions; the metabolism of mineral elements; the involvement of mineral nutrients in various physiological processes; and the nutrition of plants adapted to extreme environmental stresses (e.g., acid soils). Specific mineral elements are emphasized to illustrate these topics.

[BIOPL 644 Regulatory Factors in Plant Growth and Development
Fall. 1–2 credits (1 credit per section). Prerequisites: BIOPL 242 or 342 or equivalent, or permission of instructor. Two modules, which can be taken together or in isolation. These are compatible with BIOPL 652–03 and BIOPL 653–04 (Molecular Aspects of Plant Development II and I respectively). S-U grades optional. Offered alternate years. Not offered 2002–2003.

Section 01 Plant Hormones
1 credit. Lecs M W F 9:05 (12 lecs). P. J. Davies.
Plant Hormones: their role in plant growth and development, analysis, biosynthesis and mode of action, including signal transduction, examined from a physiological, biochemical and molecular point of view. The course covers auxin, gibberellin, cytokinin, ethylene, abscisic acid, brassinosteroids, and other compounds as appropriate.

Sec 02 Phytochrome and Photomorphogenesis
1 credit. Lecs M W F 9:05 (12 lecs). P. J. Davies.
A study of the regulation of plant growth and development by light as perceived through the pigments phytochrome and cryptochrome. This will include the biochemistry and molecular biology of phytochrome and the way in which phytochrome modulates plant growth, including molecular and genetic analysis of its effects, and the mechanisms by which it acts. The role of phytochrome in detecting and modulating growth in natural and agricultural environments is covered.]

BIOPL 647 Seminar in Systematic Botany
Fall or spring. 1 credit. May be repeated for credit. Prerequisite: written permission of course coordinator required for undergraduates. S-U grades optional. Sem, T 12:20. Bailey Hortorium staff.
Lectures and discussions led by staff, visitors, and students on topics of current importance to systematic botany.

[BIOPL 649 Physiology of Ion and Water Transport in Plants
Fall. 1–3 credits (1 credit per section). Prerequisite: BIOPL 342 or equivalent, or permission of the instructor. Three modules that may be taken independently, although section 01 is recommended before taking section 02. Offered alternate years. Not offered 2002–2003. R. M. Spanswick.

Section 01 Basic Principles of Ion Transport and Electrophysiology
1 credit. Lecs T R 10:10–11:30 (9 lecs).
The topic of this section is the biophysical basis of ion transport across cell membranes, including membrane structure, ion fluxes and their measurement, the thermodynamic criterion for active transport, and the relationship between ion transport and the electrical properties of cell membranes.

Section 02 Ion Transport in Plants
1 credit. Lecs T R 10:10–11:30 (9 lecs).
Topics include: transport of the major ions in plant cells and whole plants; properties of proton ATPases and their relationship to the transport of ions, sugars, and amino acids at the plasma membrane and tonoplast; ion channels in plant cell membranes; intercellular ion transport via plasmodesmata; and long distance ion transport in higher plants.

Section 03 Water Transport in Plants
1 credit. Lecs T R 10:10–11:30 (11 lecs).
Topics include: water relations of plant cells and tissues using water potential terminology; permeability of plant cells to water and the role of aquaporins; and transport of water through whole plants, including transpiration, stomatal physiology and the effects of water stress.]

BIOPL 652 Plant Molecular Biology II
Spring. 1–2 credits (1 credit per section). Prerequisites: BIOGD 281 and BIOBM 330 or 332, or their equivalents. Recommended: BIOBM 331. S-U grades optional.
A series of four-week modules on specialized topics. Coordinator: J. B. Nasrallah.

Section 01 Molecular Plant-Pathogen Interactions (also PL PA 662)
1 credit. Lecs, M W F 10:10 (12 lecs) Jan. 20–Feb. 14. T. P. Delaney, A. R. Collmer, S. G. Lazarowitz.
An examination of the molecular properties that control the development of host-parasite interactions in both microorganisms (bacteria, viruses, and fungi) and higher plants. Contemporary theories describing the genetic and molecular mechanisms of microbial pathogenesis and plant resistance are discussed.

[Section 02 Molecular Plant-Microbe Interactions (also BIOMI 652, PL PA 664)
1 credit. S-U grades optional. Lecs, M W F 12:20 (12 lecs). Offered alternate years. Not offered 2002–2003. S. C. Winans.
Course focuses on the interactions of *Agrobacteria* and *Rhizobia* with plants. Topics on *Agrobacterium*-plant interactions include plant-microbe recognition mechanisms, T-DNA transfer process, oncogenesis, and use of *Agrobacterium* to produce transgenic plants. Topics on *Rhizobium*-plant interactions include regulation of nitrogenase activity and expression, organization and function of the *sym* plasmid, nodule development, and plant genetics involved in plant-microbe interaction.]

Section 03 Molecular Aspects of Plant Development II
1 credit. S-U grades optional. Lecs, M W F 10:10 (12 lecs) Mar. 24-Apr. 18. T. Brutnell.
The molecular genetics of plant development. This module focuses on vegetative development and includes topics such as the development of the shoot, root, and vasculature, and the operation of the vegetative shoot apical meristem. The module is a companion to BIOPL 653, Sec 04 (Plant Development I).

Section 04 Plant Gene Evolution and Phylogeny
1 credit. Lecs, M W F 1:25 (12 lecs) Mar. 24-Apr. 18. Offered alternate years. J. J. Doyle.
Practical applications of molecular systematics/evolution for plant molecular biologists and other non-systematists. The course focuses on two basic issues: methods and principles for inferring relationships among genes and the use of data to hypothesize relationships among plants. Evolutionary patterns and processes of genes and gene families are discussed, as well as rates of sequence evolution, paralogy and orthology, the effects of recombination and concerted evolution of gene phylogenies, and the implications of using gene or allele phylogenies to infer organismal evolutionary patterns.

Section 05 Molecular Biology of Plant Organelles (also BIOBM 652.5)
1 credit. S-U grades optional. Lecs, M W F 10:10 (12 lecs) Feb. 17-Mar. 14. M. R. Hanson, D. B. Stern.
An in-depth examination of the molecular biology of plant mitochondria and plastids. Topics include the organization, evolution, and expression of organelle genomes, RNA editing, and the expression of nuclear genes encoding structural or regulatory organelle proteins. Special topics include mitochondrially-encoded cytoplasmic male sterility, transformation and expression of foreign genes in chloroplasts, and the use of genetics to investigate nucleus-organellar interactions.

Section 06 Proteomics in Plant Biology
1 credit. S-U grades optional. Lecs, M W F 1:25 (12 lecs) Mar. 24-Apr. 18. K. Van Wijk.
This course introduces proteomics and its application in Plant Biology, with special emphasis toward the chloroplast proteome. The course covers protein separation techniques where relevant for proteomics, the basics and application of mass spectrometry for identification and characterization of proteins and peptides, as well as bioinformatics tools relevant for proteomics. In addition the course deals with the proteome of the chloroplast/plastid and focuses on protein targeting, assembly, and degradation.

Section 07 Plant Cell Walls: Structure to Proteome
1 credit. S-U grades optional. Lecs, M W F 1:25 (12 lecs) Feb. 17-March 14. J. Rose.
This course examines the structure and function of plant cell walls, exploring their dynamic nature and fundamental contribution to numerous aspects of plant growth and development. Topics include: wall biosynthesis; wall structure and composition; regulation of cell expansion and differentiation; defense against pathogens and signaling; the apoplast as a metabolically active sub-cellular compartment; and analytical techniques: from biochemistry to proteomics.

BIOPL 653 Plant Molecular Biology I
Fall. 1–5 credits (1 credit per section). Prerequisites: BIOGD 281 and BIOBM 330 or 332, or their equivalents. Recommended: BIOBM 331. S-U grades optional. Coordinator: J. B. Nasrallah.
A series of four-week modules on specialized topics.

Section 01 Concepts and Techniques in Plant Molecular Biology (also PLPA 663.01)
1 credit. Lecs, M W F 10:10 (12 lecs) Sept. 4–Sept. 30. T. P. Delaney, G. B. Martin.
This is an introductory module that provides a broad overview of molecular biology concepts relevant to the plant sciences. This section serves as a prerequisite to other modules in the BIOPL 653 (fall) and BIOPL 652 (spring) series. The course is divided into two sections: 1) Gene discovery; this covers genetic, molecular, and genomics approaches to the isolation of plant genes; and 2) Gene characterization; this covers DNA sequencing, gene database analysis, assessment of gene expression, production of transgenic plants, and functional genomics approaches. Emphasis is on understanding the appropriate approach that is needed for different experiments.

Section 02 Plant Biotechnology (also PLBR 653.2 and PLPA 663.2)
1 credit. Lecs, M W F 1:25 (12 lecs) Oct. 2–Oct. 30. M. Zaitlin, E. D. Earle.
This course 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. Regulatory and social issues relating to plant biotechnology are discussed.

Section 03 Plant Genome Organization and Function (also PLBR 653.3)
1 credit. Lecs, M W F 10:10 (12 lecs) Oct. 2-Oct. 30. Offered alternate years. S. D. Tanksley.
This section covers the structure and variation of plant nuclear genomes, including changes in genome size, centromere/telomere structure, DNA packaging, transposable elements, genetic and physical mapping, positional gene cloning, genomic sequencing and comparitive genomics.

Section 04 Molecular Aspects of Plant Development I (also BIOBM 653.4)
1 credit. Lecs, M W F 10:10 (12 lecs) Nov. 1–Dec. 2. J. B. Nasrallah.
This module focuses on the molecular genetics of plant development. Current approaches to the elucidation of the molecular signals and pathways that lead to the establishment of the differentiated state of floral cells and organs are discussed. Topics include cell-cell signalling in the establishment of pattern and differentiation of specialized cell types, and the control of developmental pathways by endogenous and external cues. The module is a companion to BIOPL 652, Sec 02 (Molecular Aspects of Plant Development II).

[Section 05 Molecular Breeding and Genetic Diversity (also PLBR 653.5)
1 credit. Lecs M W F 10:10 (12 lecs). Offered alternate years. Not offered 2002–2003. S. D. Tanksley.
Application of DNA markers to the identification, manipulation and isolation of genes important to plant and animal productivity using molecular genetic techniques. Students learn how to design and execute experiments to identify quantitative trait loci (QTLs), as well as how to apply molecular markers to plant and animal breeding programs.]

[BIOPL 654 Botanical Nomenclature
Fall. 1 credit. Prerequisite: written permission of instructor. S-U grades only. Lec and disc TBA. Offered alternate years. Not offered 2002–2003. Staff.
An analysis of the International Code of Botanical Nomenclature and its application to various plant groups.]

[BIOPL 656 Topics in Plant Evolution
Spring. 1 credit. Prerequisite: BIOPL 448 or equivalent background in evolution, or written permission of instructor. Lab and disc TBA. Offered alternate years. Not offered 2002–2003. K. J. Niklas.
A series of selected topics to provide a background in plant evolution, paleobotanical literature, and evolutionary theory. Among the topics discussed are the origin of a terrestrial flora, the evolution of the seed plants, and the origin and adaptive radiation of the angiosperms.]

BIOPL 740 Plant Biology Seminar
Fall and spring. No credit (no official registration). Required of graduate students doing work in plant biology. Sem, F 11:15. Staff.
Lectures on current research in plant biology, presented by visitors and staff.

BIOPL 741 Problems in Plant Cell and Molecular Biology
Fall. 2 credits. Limited to first- and second-year graduate students in the Plant Cell and Molecular Biology Program. Disc TBA. Staff.
An introduction to the research literature in plant molecular and cellular biology through weekly problem sets and discussions.

BIOPL 742 Current Topics in Plant Molecular Biology
Fall or spring. 1 credit. Enrollment is limited. Primarily for graduate students, with preference given to majors or minors in plant molecular biology; written permission of instructor required for undergraduates. S-U grades only. Sem, 1 hour each week TBA. Staff.

BIOPL 743 Current Research in Plant Cell and Molecular Biology
Fall. 1 credit. Limited to graduate students; written permission from a member of the Plant Cell and Molecular Biology Program or by permission of coordinator required for undergraduates. Disc TBA. Staff.
An introduction for graduate students to the research being conducted by Cornell faculty in the Plant Cell and Molecular Biology Program.

BIOPL 744 Research Seminar in Plant Cell and Molecular Biology
Fall or spring. 1 credit. Seminar R 12:20. Staff.
Required of, and limited to, second-, third-, and fourth-year graduate students in Plant Cell and Molecular Biology. Each student presents one seminar per year on his or her thesis research, and then meets with the thesis committee members for evaluation.

BIOPL 745 Current Topics in Systematics
Fall. 1 credit. Limited to graduate students, except by permission of instructor. S-U grades optional. Disc, T 12:20. Bailey Hortorium staff.
A seminar with presentations and discussion by students of original research papers in systematic biology.

BIOPL 746 Research Seminar in Systematic Botany
Spring. 1 credit. Limited to graduate students, except by permission of instructor. Disc, T 12:20. Bailey Hortorium staff.
A student-led seminar presentation based on his or her thesis research or a related topic.

BIOPL 749 Graduate Research in Botany
Fall or spring. Variable credit. May be repeated for credit. S-U grades optional. Staff.
Similar to BIO G 499 but intended for graduate students who are working with faculty members on an individual basis.

Related Courses in Other Departments

Introductory Mycology (Plant Pathology 309)

Marine Botany: Ecology of Marine Plants (Biological Sciences [BIOSM] 449)

Mycology Conferences (Plant Pathology 649)

Physiological Plant Ecology, Lectures and Laboratory (Biological Sciences [BIOEE] 466 and 468)

Phytomycology (Plant Pathology 709)

Plant Ecology and Population Biology, Lectures and Laboratory (Biological Sciences [BIOEE] 463 and 465)

Plant Ecology Seminar (Biological Sciences [BIOEE] 669)

Plant Cytogenetics Laboratory (Plant Breeding 446)

Teaching Experience (Biological Sciences [BIO G] 498)

Undergraduate Research in Biology (Biological Sciences [BIO G] 499)

COURSES IN MARINE SCIENCE

Cornell offers an extensive listing of undergraduate courses in marine science.

Undergraduates interested in pursuing studies in marine science are encouraged to explore the undergraduate specialization in Marine Biology offered through the Office of Undergraduate Biology, the undergraduate specialization in Ocean Sciences offered through the Science of Earth Systems Program, and the summer program of courses offered by the Shoals Marine Laboratory. Further information on these programs can be found at the Cornell Marine Programs Office, G14 Stimson Hall, or on their web site, www.sml.cornell.edu.

Undergraduate Specialization in Marine Biology and Oceanography

Biological Sciences majors in the Ecology and Evolutionary Biology program of study have the option of specializing their program of study in the area of Marine Biology. This specialization is intended for students with interests in understanding the unique aspects of organismal biology in the marine environment. In addition to fulfilling the major and

the ecology and evolutionary biology program of study requirements, students in marine biology are encouraged to enroll in the following courses:

1) BIOEE 154, The Sea: An Introduction to Oceanography,
2) BIOSM 364, Field Marine Science, BIOSM 375 Field Marine Biology and Ecology, and/or at least one 400-level BIOSM field course at the Shoals Marine Laboratory,
3) BIOEE 462, Marine Ecology.

Undergraduate Specialization in Ocean Sciences

Science of Earth Systems majors have the option of specializing their program of study in the area of ocean sciences. This interdisciplinary specialization is intended for students with interests in understanding the interaction of biological, chemical, geological, and physical processes in ocean systems. In addition to fulfilling the Science of Earth Systems general requirements (see the SES program description in Interdisciplinary Centers, Programs, and Studies section of catalog), students in ocean sciences are required to take four advanced courses from the following list to fulfill their major requirements:

1) BIOEE 373 Biology of the Marine Invertebrates
2) BIOEE 457 Limnology
3) BIOEE 462 Marine Ecology
4) BIOEE 478 Ecosystem Biology
5) BIOEE 490 Topics in Marine Biology
6) BIOSM 303 Ecology of Marine Fishes
7) BIOSM 308 Marine Microbial Ecology
8) BIOSM 309 Climates and Ecosystems
9) BIOSM 329 Ecology of Animal Behavior
10) BIOSM 364 Field Marine Science
11) BIOSM 365 Underwater Research
12) BIOSM 374 Field Ornithology
13) BIOSM 375 Field Marine Biology and Ecology
14) BIOSM 413 Research in Marine Biology
15) BIOSM 418 Tropical Marine Science
16) BIOSM 449 Seaweeds, Plankton and Seagrass
17) BIOSM 376 Marine Invertebrate Zoology (note: not the same as BIOEE 373)
18) BIOSM 477 Marine Vertebrates
19) EAS 375 Sedimentology and Stratigraphy
20) EAS 455 Geochemistry
21) EAS 475 Special Topics in Oceanography
22) EAS 479 Paleobiology
23) NTRES 306 Coastal and Oceanic Law and Policy
24) NTRES 417 Wetland Resources

Sea Semester

BIOSM 366 SEA: Introduction to Oceanography

BIOSM 367 SEA: Introduction to Maritime Studies

BIOSM 368 SEA: Introduction to Nautical Science

BIOSM 369 SEA: Practical Oceanography I

BIOSM 370 SEA: Practical Oceanography II

Students in both marine science specializations are exposed to an integrated program of study, emphasizing a natural progression of formal course work combined with ample opportunities for practical field experience.

These courses must be taken concurrently. Special program run by the Sea Education Association. Contact Marine Programs Office (607–255–3717) for more details.

SHOALS MARINE LABORATORY (BIOSM)

G14 Stimson Hall, 255–3717

The objective of the Shoals Marine Laboratory (SML) is to provide undergraduates and other interested adults a unique opportunity to explore marine sciences in an island setting noted for its biota, geology, and history. SML has established a national reputation for excellence and has become North America's largest marine field station focusing on undergraduate education.

The summer population of Appledore Island is limited to about one hundred people at any one time. Participants and faculty members can literally and figuratively immerse themselves in their explorations, free from distractions common to most academic institutions. Because SML is a residential facility, a sense of community develops that makes courses and seminars at SML outstanding educational and intellectual experiences. Participants learn from and exchange ideas with a wide range of specialists whose primary interests are marine but whose perspectives often differ, providing fertile ground for lively discussions.

Credit courses at Shoals Marine Laboratory are full-time, intensive learning experiences. Courses may be taken sequentially, but **not** concurrently. A typical day combines lecture sessions, laboratory and field work, field trips to nearby islands and the mainland, and collecting and research excursions aboard the Laboratory's 47-foot research vessel, *John M. Kingsbury* or the 36-foot research vessel *John B. Heiser*. Field experience is an integral component of all courses, using Appledore's extensive intertidal and subtidal zones, wading bird rookeries, and seabird colonies. Faculty, drawn from Cornell University, the University of New Hampshire, and other leading academic institutions, are selected not only based on their academic excellence, but also on their teaching ability in the field. In addition, there are numerous guest lecturers including engineers, coastal planners, and specialists from private industry, government, and the academic community.

The Ithaca campus functions of the Shoals Marine Laboratory are centered in the Cornell Marine Programs Office, G14 Stimson Hall. The office serves as an advising center for students interested in the marine sciences, maintains a browsing library with updated information on graduate study and career opportunities as well as on marine programs at other institutions, and administers the SEA Semester, a 17-credit program offered in cooperation with the Sea Education Association (SEA).

The following marine sciences courses are currently administered by the Cornell Marine Programs Office. (Not all of these courses are offered each semester, consult the SML catalog for current offerings.)

BIOSM 160 The Oceanography of the Gulf of Maine
Summer. 4 credits. Limited to 24 students. A special 2-week course offered aboard a SEA vessel and at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N.H. For more details or an application, contact the SML office, G14 Stimson Hall or the Sea Education Association office at P.O. Box 6, Woods Hole, MA, 02543. Daily lecs, labs, and fieldwork for 2 weeks. SML faculty.
An exciting opportunity to explore the offshore and near-coastal environments of the Gulf of Maine for pre-college and first-year non-science majors. Students spend 10 days aboard the Sea Education Association's sailing vessels round trip between Woods Hole, Mass., and the Isles of Shoals via Georges Bank and the Gulf of Maine. Besides operating the ship, students study the many characteristics of this unique ocean environment. Following the sea component, students spend seven days at the Shoals Marine Laboratory collecting data characteristic of the Isles of Shoals coastal environment.

BIOSM 161 Introduction to Marine Science
Summer. 4 credits. S-U grades optional. A special 2-week course offered in cooperation with Rider University at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N.H. Apply directly to Rider University, College of Continuing Studies. Contact Dr. Richard Alexander for application and information at: Alexander@enigma.rider.edu, (609) 895–5422. Offered alternate years.
This course allows students who are not biology majors to experience the breadth of the marine sciences under field conditions at an island laboratory. Aspects of biology, geology, earth science, chemistry, and physics are included. Specific topics include: beach, salt marsh, tidal mud flat, tide pool, and benthic offshore environments; identification of marine plants and animals; chemical and physical oceanography; marine geology; and ecology of kelp beds and urchin barrens.

BIOSM 204 Biological Illustration
Summer. 2 credits. A special 1-week course offered at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N.H. For more details or an application, consult the SML office, G14 Stimson Hall. Daily sessions for 1 week. SML faculty.
General discussion of scientific publishing, illustration labeling, color techniques, and printing processes. The course provides the scientist or science student a chance to experience several illustration techniques with the goal of obtaining an overview of scientific and wildlife illustrations. The student may choose a single technique to explore in depth. Course size is limited so that individual attention can be emphasized.

BIOSM 303 Ecology of Marine Fishes
Summer. 4 credits. Prerequisite: 1 year of college-level biology. SCUBA certification recommended, not required. S-U grades optional. A special 2-week course offered at Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details or an application, consult the SML office, G14 Stimson Hall. Daily lecs and fieldwork for 2 weeks. SML staff.

This course presents principles, models, and methods for analysis of dynamics of fish populations and communities, and analysis of current research emphasizing theory and its potential uses in fisheries' management. Lab and field activities emphasize collection and analysis of data from the Gulf of Maine and adjacent estuarine habitats.

BIOSM 308 Marine Microbial Ecology
Summer. 4 credits. Prerequisite: 1 year of college-level biology. S-U grades optional. A special 2-week course offered at Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details or an application, consult the SML office, G14 Stimson Hall. Daily lecs and fieldwork for 2 weeks. SML staff.
This course examines the fundamental role of marine microbial communities in the function of the biosphere. Lectures survey bacterial, protozoan, and micrometazoan assemblages from Arctic to deep sea vent communities. Laboratory exercises cover several principal techniques of field microbial ecology and explore the rich marine microbial environment surrounding the Isles of Shoals.

BIOSM 309 Climates and Ecosystems
Summer. 4 credits. Prerequisite: 1 year of college-level biology; background preferred in physics/physical geography. S-U grades optional. A special 2-week course offered at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N.H. For more details or an application consult the SML office, G14 Stimson Hall. Daily lecs, labs, and fieldwork for 2 weeks. SML faculty.
A study of the fundamentals of organism-environment interaction developed through defining and measuring abiotic factors including solar radiation, temperature, atmospheric moisture, precipital wind, and currents. On-site exploration of the dynamics of meteorology and the role of abiotic and biotic factors in the life of coastal and marine plants and animals including humans.

BIOSM 329 Ecology of Animal Behavior (also BIONB 329)
Summer. 4 credits. Prerequisite: 1 year of introductory college biology. Recommended: course work in ecology, psychology, or behavior. S-U grades optional. A special 2-week course offered at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Daily lecs, labs, and fieldwork for 2 weeks. SML faculty.
The ecological significance of behaviors of coastal organisms, with emphasis on field and laboratory research methods. Lectures and readings address the major subareas of behavior (communication, orientation, social behavior, foraging, predator avoidance, and sensory mechanisms). Each student engages in short-term behavioral observation and prepares a research proposal for studying a problem within the course subject area.

BIOSM 363 Marine Biology for Teachers
Summer. 3 or 4 credits (4-credit option: additional 4 days for individual research). Primarily for teachers, grades 6 through 12, but open to others with teaching experience. Prerequisite: 1 year of introductory college biology. S-U grades optional. A special 10-day course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details or an application, consult the SML office, G14 Stimson Hall. Daily lecs, labs, and fieldwork for 10 days. Offered alternate years. SML faculty.
Designed to give an overview of living marine organisms (algae, invertebrates, fishes, marine mammals, and shorebirds) and of the environment they inhabit. Fieldwork is emphasized. Occasional lectures and films deal with additional topics such as coastal-zone problems, marine fisheries, economics of marine organisms, and educational resources of the marine environment.

BIOSM 364 Field Marine Science (FMS)
Summer. 6 credits. Prerequisite: 1 year of college biology. S-U grades optional. A special 4-week course offered twice each summer at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. Students may not take FMS after taking FMBE (BIOSM 375). For more details or an application, consult the SML Office, G14 Stimson Hall. Daily lecs, labs, and fieldwork for 4 weeks. 3 core faculty members assisted by up to 15 visiting lecturers, including representatives of governmental agencies. SML faculty.
Designed for the student who desires an initial overview of the marine sciences, this course emphasizes living material in natural habitats. Most of the course work is concerned with the biology of intertidal plants and animals, biological oceanography, ichthyology, and fisheries. Attention is also given to introductory physical and chemical oceanography and marine geology. Marine ecology and the effects of human activity on the marine environment are included. Students apply this knowledge by conducting a transect study toward the end of the course. FMS places emphasis on ichthyology, fisheries biology, general oceanography (biological, physical, and chemical) and marine geology. FMBE (BIOSM 375) places an additional emphasis on ecology, especially in the intertidal zone; ecological, evolutionary and physiological adaptations of marine organisms; and field experiments.

BIOSM 365 Underwater Research
Summer. 4 credits. Prerequisites: 1 year of college-level biology, recognized scuba certification, and a medical examination. S-U grades optional. A special 2-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details or an application, consult the SML office, G14 Stimson Hall. Daily lecs and fieldwork for 2 weeks. Team-taught by 3 faculty members with occasional guest lecturers. Not for recreational divers.
Course covers the philosophy of research, hypothesis testing and experimental design, sampling methods, various underwater techniques, diving physics and physiology, and use of dive tables. Emphasis is on subtidal ecological research. Requirements include critical evaluation of several journal articles and production of a research proposal.

BIOSM 374 Field Ornithology
Summer. 4 credits. Prerequisite: 1 year of college-level biology. S-U grades optional. A special 2-week course offered at Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details or an application, consult the SML office, G14 Stimson Hall. Daily lecs and fieldwork for 2 weeks. SML staff.
An introduction to field ornithology focusing on the biology, ecology, and behavior of the avifauna on the Isles of Shoals. The course focuses on field work designed to observe and study many concepts frequently taught in the classroom setting including territoriality, breeding biology, and survivorship. Students learn and apply numerous ornithological field methods including various census techniques, territory mapping, banding, behavioral observations, and creating a field notebook.

BIOSM 375 Field Marine Biology and Ecology (FMBE)
Summer. 6 credits. Prerequisites: 1 full year of college level biology. S-U grades optional. A 4-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details or an application, consult the SML Office, G-14 Stimson Hall. Daily lecs, labs, and fieldwork for 4 weeks. SML faculty.
Designed for students seeking an introduction to the marine sciences and marine ecology; FMBE emphasizes field work in natural habitats. Examines aspects of the biology and ecology of marine organisms, including intertidal plants and invertebrates, fishes, marine mammals and birds, biological oceanography, and human impacts on the marine environment. FMBE places a special emphasis on the ecology of the intertidal zone, and ecological, evolutionary and physiological adaptations of marine organisms. Students may not take FMBE after taking FMS (BIOSM 364).

BIOSM 376 Marine Invertebrate Zoology
Summer. 6 credits. Prerequisite: 1 year of introductory biology and permission of instructors. Students may not take BIOSM 376 after taking BIOEE 373. S-U grades optional. A special 3-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details or an application, consult the SML office, G14 Stimson Hall. Daily lecs, labs, and fieldwork for 3 weeks. Offered alternate years. SML faculty.
An introduction to the biology and evolution of the major invertebrate phyla, concentrating on marine representatives. Emphasis is placed on the evolution of form and function, and the ecology, behavior, physiology, chemical ecology, and natural history of invertebrates. Appledore Island's unique location provides an excellent venue for the study of freshly collected and *in situ* representatives of most of the major phyla.

BIOSM 402 Marine Pollution
Summer. 4 credits. Prerequisites: 1 year of college-level biology and chemistry or permission of instructor. S-U grades optional. A special 2-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details or an application, consult the SML office, G14 Stimson Hall. Daily lecs, labs, and fieldwork for 2 weeks. Offered alternate years. SML faculty.
An introduction to marine pollutants; their sources and control/treatment; the effects of marine pollution upon coastal ecosystems; and federal and state water pollution regulatory programs. Laboratory includes training in field collection of water samples, measurement and modeling of effluent plume dispersion, and measurement of microbial indicators of water quality, dissolved nutrients, BOD, dissolved oxygen, and toxicity.

BIOSM 413 Research in Marine Biology
Summer. 6 credits. Prerequisite: 1 year of college level biology; experience in ecology or physiology recommended. S-U grades optional. A special 3-week course offered at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N.H. For more details or an application, consult the SML office, G14 Stimson Hall. Daily lecs, labs, and fieldwork for 3 weeks. SML faculty.
An introduction to the physiological ecology and functional morphology of marine plants and animals, with emphasis on selected algal and invertebrate examples from the Gulf of Maine. Topics covered include photosynthesis in the marine environment; respiration in intertidal organisms; carbohydrates, proteins, and lipids as nutrients in the sea; acclimation and tolerance of tide-pool biota; and biological responses to competition and grazing. Field and laboratory exercises explore principles and procedures used to characterize the physical, chemical, and biotic environment of intertidal and shallow subtidal organisms, including determination of temperature, light, salinity, oxygen and nutrient levels, and *in vivo* functional analyses of metabolic phenomena. The process of scientific investigation is the predominant theme of the course.

BIOSM 418 Tropical Marine Science
Summer. 8 credits and 4 credits of research. Limited to 12 students. Prerequisites: 1 year college-level biology; recognized SCUBA certification; medical exam; and permission of instructor. A special 8-week course offered in Akumal, Mexico. For more details, contact Shoals Marine Laboratory, G-14 Stimson Hall, 255–3717. For certified divers only. Lec/lab, 2 weeks; 6 weeks monitoring study and individual research projects, including data analysis on computers. SML faculty.
In addition to lectures and laboratories covering the basic principles of coral reef ecology, students participate in a coral reef monitoring survey. Following two weeks of course work, students engage in independent research projects.

BIOSM 449 Seaweeds, Plankton and Seagrass: the Ecology and Systematics of Marine Plants
Summer. 4 credits. Prerequisite: BIOSM 364 or 1 year of introductory biology. S-U grades optional. A special 2-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details or an application, consult the SML office, G14 Stimson Hall. Daily lecs, labs, and fieldwork for 2 weeks. SML faculty.
An overview of the major marine algal groups, including aspects of anatomy, morphology, development, life histories, physiology, and use. Laboratories and fieldwork emphasize relationships between distribution and major environmental parameters and involve student projects.

EAS 475 Special Topics in Oceanography: Satellite Remote Sensing in Biological Oceanography
Summer. 6 credits. Prerequisites: 1 course in oceanography and/or marine biology, or permission of the instructor. Strong computer skills are desired. S-U grades optional. A special 4-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. and on campus at Cornell University. For more details or an application, consult the SML office, G14 Stimson Hall. Daily lecs, labs, and fieldwork for 4 weeks. Offered alternative years. SML faculty.
"Remote Sensing" provides hands-on research experience in hydrologic optics and satellite remote sensing to advanced undergraduate and beginning graduate students. The course is comprised of four principal parts, each taught by a separate team of instructors at two different locations: Part 1 (nine days) will be conducted at Shoals Marine Laboratory and aboard the *R/V Kingsbury* in waters surrounding the Isles of Shoals. Part 1 will be devoted to the theory and measurement of seawater optical properties, emphasizing the dependency of apparent optical property on chlorophyll and dissolved organic matter concentrations. Parts 2–4 (19 days) will be conducted at the Science of Earth Systems' computer laboratory on the Cornell campus. Part 2 will cover satellite remote sensing of the apparent optical properties of seawater with an emphasis on processing SeaWiFS data using SeaDAS software and IDL programming language. Part 3 addresses satellite remote sensing of physical oceanographic processes that influence ecosystem dynamics with an emphasis on AVHRR-derived sea-surface temperature and SSM/I-derived ocean winds. Part 4 is devoted to independent projects; student will attempt to integrate SeaWiFS, AVHRR, and SSM/I data in order to address questions of biological-physical interactions.

BIOSM 477 Marine Vertebrates
Summer. 6 credits. Prerequisites: a course in vertebrate biology. S-U grades optional. A special 3-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details or an application, consult the SML office, G14 Stimson Hall. Daily lecs, labs, and fieldwork for 3 weeks. SML faculty.
Topics in marine vertebrate biology emphasizing laboratory studies, field collections or observations, and readings from the current literature. Topics covered include: systematics of fishes of the Gulf of Maine; elasmobranch physiology; interpretation of life history and parameters from otolith microstructure; teleost skeletomuscular structure and function; population biology and the contemporary Gulf of Maine fishery; Mesozoic marine reptiles; the biology of sea turtles in cold water; coloniality in sea birds; avian adaptations to life at sea; evolution and systematics of marine mammals; diving physiology; and ecology and conservation of existing marine mammal populations. Dissection of vertebrate animals is a part of one or more laboratory sessions.

BIOSM 495 Research Methods in Marine Biology
Summer. 1 credit. Prerequisite: concurrent enrollment in BIOSM 499, or permission of instructor. Primarily for undergraduates. A special 8 week course offered at the Shoals Marine Laboratory (SML). For more details or an application, consult the SML office, G14 Stimson Hall. Weekly seminars for 8 weeks. J. G. Morin and M. J. Shulman.
Seminar course on research methodology, experimental design, statistical analyses, and scientific writing. The course is designed to assist students in the research they are conducting while enrolled in BIOSM 499.

BIOSM 499 Research in Biology
Summer. Credits variable (2 credits/7 days on site). For more details and an application, consult the SML Office, G14 Stimson Hall.

Section A: Independent Biological Research: Independent study with a member of the Shoals Marine Laboratory core faculty, based on student faculty interest and available facilities. A short proposal of research must be sent with application materials.

Research Experiences for Undergraduates (REU)
0 credit. The National Science Foundation (NSF) Research Experiences for Undergraduates (REU) program provides support for undergraduates to pursue supervised, independent research projects at the Shoals Marine Laboratory. Nine students will be selected from a competitive, national pool to participate in the eight-week summer program. For more information and an application, please contact the SML office, G14 Stimson Hall, or view SML's web site at: www.sml.cornell.edu

ARKEO 319 Archaeology Underwater
Summer. 2 credits. Prerequisites: recognized scuba certification and a medical examination required for students engaging in underwater research; also open to non-divers. A special 1-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details or an application, consult the SML office, G14 Stimson Hall. Daily lecs, labs, and fieldwork for 1 week. Offered alternate years. SML faculty.
An introduction to the subject and a review of this contemporary subdiscipline of archaeology. The approach of the course is practical, with a strong potential for actual on-site experience in search, site recognition, survey, and recording. The course also covers the history and development of the subject, the legal aspects of underwater research, and the worldwide potential of the field. Since any archaeological research project involves a great deal more than digging, the course provides ample opportunities for those who are interested in the subject but are not divers or sufficiently experienced in scuba.

EAS 213 Marine and Coastal Geology
Summer. 2 credits. Prerequisite: an introductory course in geology or permission of instructor. A special 1-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details or an application, consult the SML office, G14 Stimson Hall. Daily lecs, labs, and fieldwork for 1 week. SML faculty.
This course examines the complete history of the Isles of Shoals from Paleozoic intrusion, deformation and metamorphism to recent glaciation, sea-level change and wave erosion. Students learn basic surveying and mapping techniques using the Brunton compass, poplevel/stadia rod, autolevel and GPS. Field efforts focus on creating a series of thematic maps depicting island characteristics such as topography, bedrock geology and structure, vegetation, and land use patterns.

NTRES 306 Coastal and Oceanic Law and Policy
Summer. 2 credits. A special 1-week course offered at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N.H. For more details or an application, consult the SML office, G14 Stimson Hall. Daily lecs and disc for 1 week. SML faculty.
Intended for people interested in careers in management of marine or coastal resources or in the natural sciences. Subjects include law and policy related to ocean dumping, marine sanctuaries, environmental impact statements, water and air pollution, fisheries management, offshore gas and oil production, and territorial jurisdiction. Lectures on the status and history of law are accompanied by discussion of relevant policy and analysis of the efficacy of various legal techniques. A case study that requires extensive use of the laboratory's library and personnel is assigned. The week concludes with a mock hearing.

NTRES 417 Wetland Resources
Summer. 2 credits. Prerequisite: 1 year of college-level biology. A special 1-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details or an application, consult the SML office, G14 Stimson Hall. Daily lecs, labs, and fieldwork. SML faculty.
An examination of coastal and adjacent freshwater wetlands from historic, destruction, and preservation perspectives, including fresh- and salt-marsh ecology and management. Field trips to selected examples of the wetlands under discussion and follow-up laboratories emphasize successional features, plant identification and classification, and examination of the dominant insect and vertebrate associations.

BIOEE 373 Biology of the Marine Invertebrates
Fall (but taken in the previous summer at the Shoals Marine Laboratory [SML]). 4 credits. Limited to 30 students. Prerequisite: 1 year of introductory biology for majors. Students may not take BIOEE 373 after taking BIOSM 376. Permission of faculty required. 2-week, full-time course. Daily and evening lectures, laboratories, and field work. Offered alternate years. C. D. Harvell, J. G. Morin, SML faculty.
An introduction to the biology and evolution of the major invertebrate phyla, concentrating on marine representatives. In addition to the evolution of form and function, lectures cover aspects of ecology, behavior, physiology, chemical ecology, and natural history of invertebrates. By being taught at the Shoals Marine Laboratory, students are exposed to a wealth of marine and terrestrial invertebrates in their natural habitats. Regular field excursions allow an excellent opportunity to study freshly collected and *in situ* representatives of most of the major phyla.

BIOSM 366–372 SEA Semester
In cooperation with the Sea Education Association (SEA), the Shoals Marine Laboratory offers a semester-length sequence of courses designed to provide college undergraduates with a thorough academic, scientific, and practical understanding of the sea. *This sequence is repeated approximately once every two months throughout the year.* Students spend the first half of SEA Semester (a six-week shore component) in Woods Hole, MA, receiving instruction in oceanography, nautical science, and maritime studies. The second half of SEA Semester (a six-week sea component) is spent at sea aboard the SSV *Robert C. Seamans* or the SSV *Corwith Cramer*. Enrollment is open to both men and women judged capable of benefiting from SEA semester; a student must have successfully completed **at least one college-level laboratory science course** (or its equivalent) in order to be admitted to SEA Semester or SEA Summer Session. **No prior sailing experience is necessary**. Cornell students enrolled in the SEA Semester must take the entire sequence.

For more information, contact the Shoals Marine Laboratory office, G14 Stimson Hall, or call SEA directly at 800–552–3633. Program costs are to be paid in place of regular Cornell tuition and fees: tuition for the entire 17-credit SEA Semester, approximately $17,000 which includes room and board at SEA.

Instructors for the SEA Semester include faculty of the Sea Education Association and the Woods Hole Oceanographic Institution and others.

Shore Component (six weeks)

BIOSM 366 SEA Introduction to Oceanography
3 credits. Prerequisite: concurrent enrollment in BIOSM 367 and 368.
A survey of the characteristics and processes of the global ocean. Oceanographic concepts are introduced and developed from their bases in biology, physics, chemistry, and geology. Provides a broad background in oceanography with special attention to areas pertinent to the subsequent cruise. Guest lecturers from the Woods Hole research community interpret current trends and activities in this rapidly evolving field. Students develop individual projects to be carried out at sea.

BIOSM 367 SEA Introduction to Maritime Studies
3 credits. Prerequisite: concurrent enrollment in BIOSM 366 and 368.
An interdisciplinary consideration of our relationship with the marine environment. Covers the elements of maritime history, law, literature, and art necessary to appreciate our marine heritage and to understand the political and economic problems of contemporary maritime affairs.

BIOSM 368 SEA Introduction to Nautical Science
3 credits. Prerequisites: concurrent enrollment in BIOSM 366 and 367.
An introduction to the technologies of operation at sea. The concepts of navigation (piloting, celestial and electronic), naval architecture, ship construction, marine engineering systems, and the physics of sail are taught from their bases in astronomy, mathematics, and physics. Provides the theoretical foundation for the navigation, seamanship, and engineering that students employ at sea.

Sea Component (six weeks)

Courses 369, 370 and 372 take place aboard the SSV *Robert C. Seamans*, a 134-foot steel auxiliary-powered brigantine schooner built in 2001, or the SSV *Corwith Cramer*, a 134-foot steel auxiliary-powered brigantine built in 1987 for SEA. Both ships normally put to sea with a ship's company of 34. The professional staff of nine includes the captain, the chief scientist, three science watch officers, three deck watch officers, an engineer, and a steward. In addition, one or more visiting investigators are frequently aboard. Up to 24 students round out the complement.

BIOSM 369 SEA Practical Oceanography I
4 credits. Prerequisite: BIOSM 366.
Theories and problems raised in the shore component are tested in the practice of oceanography at sea. Students are introduced to the tools and techniques of the practicing oceanographer. During lectures and watch standing, students are instructed in the operation of basic oceanographic equipment: in the methodologies involved in the collection, reduction, and analysis of oceanographic data; and in the attendant operations of a sailing oceanographic research vessel.

BIOSM 370 SEA Practical Oceanography II
4 credits. Prerequisites: BIOSM 368 and 369.
Building on the experience of Practical Oceanography I, students assume increasing responsibility for conducting oceanographic research and overseeing operations of the vessel. The individual student is ultimately responsible directly to the chief scientist and the master of the vessel for the safe and orderly conduct of research activities and related operations of the vessel. Each student undertakes an individual research project designed during the shore component.

BIOSM 372 SEA Practical Oceanography III
Summer. 3 credits. Prerequisites: BIOSM 366, 367, and 368.
Theories and problems raised in class are tested in the practice of oceanography at sea. During lectures and watch standing, students are instructed in the operation of basic oceanographic equipment, in the methodologies involved in the collection, analysis, and reduction of oceanographic data, and in the attendant operations of sailing an oceanographic research vessel. Group research projects are completed.

FACULTY ROSTER

New York State College of Agriculture and Life Sciences

Adler, Kraig K., Ph.D., U. of Michigan. Prof., Neurobiology and Behavior
Alani, Eric E., Ph.D., Harvard U. Assoc. Prof., Molecular Biology and Genetics
Anderson, John M., Ph.D., New York U. Prof. Emeritus, Molecular Biology and Genetics
Angert, Esther R., Ph.D., Indiana U. Asst. Prof., Microbiology
Bates, David M., Ph.D., U. of California at Los Angeles. Prof., Plant Biology (Bailey Hortorium)
Beyenbach, Klaus W., Ph.D., Washington State U. Prof., Physiology/Veterinary Physiology†
Bruns, Peter J., Ph.D., U. of Illinois. Prof. Emeritus, Molecular Biology and Genetics
Cade, Thomas J., Ph.D., U. of California at Los Angeles. Prof. Emeritus, Ecology and Evolutionary Biology
Calvo, Joseph M., Ph.D., Washington State U. William T. Keeton Professor in Biological Sciences, Molecular Biology and Genetics

Chabot, Brian F., Ph.D., Duke U. Prof., Ecology and Evolutionary Biology
Clayton, Roderick K., Ph.D., California Inst. of Technology. Prof. Emeritus, Plant Biology
Crepet, William L., Ph.D., Yale U. Prof., Plant Biology (Bailey Hortorium)*
Davies, Peter J., Ph.D., U. of Reading (England). Prof., Plant Biology
Davis, Jerrold I., Ph.D., U. of Washington. Assoc. Prof., Plant Biology (Bailey Hortorium)
Dhondt, André A., Ph.D., Ghent State U. (Belgium). Edwin H. Morgens Professor of Ornithology, Ecology and Evolutionary Biology/Laboratory of Ornithology
Dondero, Norman C., Ph.D., Cornell U. Prof. Emeritus, Microbiology
Doyle, Jeffrey J., Ph.D., Indiana U. Prof., Plant Biology (Bailey Hortorium)
Dress, William J., Ph.D., Cornell U. Prof. Emeritus, Plant Biology (Bailey Hortorium)
Eisner, Thomas, Ph.D., Harvard U. Jacob Gould Schurman Professor, Neurobiology and Behavior*
Emlen, Stephen T., Ph.D., U. of Michigan. Jacob Gould Schurman Professor, Neurobiology and Behavior
Feeny, Paul P., Ph.D., Oxford U. (England). Prof., Ecology and Evolutionary Biology
Fitzpatrick, John W., Ph.D., Princeton U. Prof., Ecology and Evolutionary Biology/ Laboratory of Ornithology
Flecker, Alexander S., Ph.D., U. of Maryland. Asst. Prof., Ecology and Evolutionary Biology
Fox, Thomas D., Ph.D., Harvard U. Prof., Molecular Biology and Genetics
Fu, Jianhua, Ph.D., U. Pittsburgh. Asst. Prof., Molecular Biology and Genetics
Ghiorse, William C., Ph.D. Rensselaer Polytechnic Inst. Prof., Microbiology
Gibson, Jane, Ph.D., U. of London (England). Prof. Emeritus, Molecular Biology and Genetics
Goldberg, Michael L., Ph.D., Stanford U. Prof., Molecular Biology and Genetics
Hanson, Maureen R., Ph.D., Harvard U. Prof., Molecular Biology and Genetics/Liberty Hyde, Prof., Plant Biology
Harrison, Richard G., Ph.D., Cornell U. Prof., Ecology and Evolutionary Biology
Harris-Warrick, Ronald M., Ph.D., Stanford U. Prof., Neurobiology and Behavior
Harvell, C. Drew, Ph.D., U. of Washington. Prof., Ecology and Evolutionary Biology
Hay, Anthony, Ph.D., U. of California. Asst. Prof., Microbiology
Helmann, John D., Ph.D., U. of California at Berkeley. Assoc. Prof., Microbiology
Henry, Susan, Ph.D., U. of California Berkley. Prof., Molecular Biology and Genetics and Dean CALS
Hopkins, Carl D., Ph.D., Rockefeller U. Prof., Neurobiology and Behavior
Howarth, Robert W., Ph.D., Massachusetts Inst. of Technology/Woods Hole Oceanographic Institution. David R. Atkinson Professor in Ecology and Environmental Biology, Ecology and Evolutionary Biology/ Earth and Atmospheric Sciences
Hua, Jian, Ph.D., California Inst. Of Technology. Asst. Prof., Plant Biology
Ingram, John W., Ph.D., U. of California at Berkeley. Prof. Emeritus, Plant Biology (Bailey Hortorium)
Jagendorf, André T., Ph.D., Yale U. Liberty Hyde Bailey Professor of Plant Physiology Emeritus, Plant Biology
Kemphues, Kenneth J., Ph.D., Indiana U. Prof., Molecular Biology and Genetics
Kingsbury, John M., Ph.D., Harvard U. Prof. Emeritus, Plant Biology
Kraus, Lee, Ph.D., U. of Illinois. Asst. Prof., Molecular Biology and Genetics
Lis, John T., Ph.D., Brandeis U. Prof., Molecular Biology and Genetics
Loew, Ellis R., Ph.D., U. of California at Los Angeles. Prof., Physiology/Veterinary Physiology†
Lovette, Irby J., Ph.D., U. of Pennsylvania. Asst. Prof., Ecology and Evolutionary Biology/Laboratory of Ornithology
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MacDonald, Russell E., Ph.D., U. of Michigan. Prof. Emeritus, Molecular Biology and Genetics
MacIntyre, Ross J., Ph.D., Johns Hopkins U. Prof., Molecular Biology and Genetics
Madsen, Eugene L., Ph.D., Cornell U. Asst. Prof., Microbiology
Marks, Peter L., Ph.D., Yale U. Prof., Ecology and Evolutionary Biology
McCune, Amy R., Ph.D., Yale U. Assoc. Prof., Ecology and Evolutionary Biology
Morin, James G., Ph.D., Harvard U. Prof., Ecology and Evolutionary Biology
Mortlock, Robert P., Ph.D., U. of Illinois. Prof. Emeritus, Microbiology
Nasrallah, June B., Ph.D., Cornell U. Prof., Plant Biology
Nasrallah, Mikhail E., Ph.D., Cornell U. Prof., Plant Biology
Naylor, Harry B., Ph.D., Cornell U. Prof. Emeritus, Microbiology
Niklas, Karl J., Ph.D., U. of Illinois. Prof., Plant Biology
Nixon, Kevin C., Ph.D., U. of Texas at Austin. Assoc. Prof., Plant Biology (Bailey Hortorium)
Owens, Thomas G., Ph.D., Cornell U. Assoc. Prof., Plant Biology
Paolillo, Dominick J., Jr., Ph.D., U. of California at Davis. Prof. Emeritus, Plant Biology
Parthasarathy, Mandayam V., Ph.D., Cornell U. Prof., Plant Biology†
Quaroni, Andrea, Ph.D., U. of Pavia (Italy). Prof., Physiology/Veterinary Physiology†
Reeve, H. Kern, Ph.D., Cornell U. Assoc. Prof., Neurobiology and Behavior
Roberts, Jeffrey W., Ph.D., Harvard U. Robert J. Appel Professor of Cellular and Molecular Biology, Molecular Biology and Genetics
Rodriguez, Eloy, Ph.D., U. of Texas. Prof., Plant Biology (Bailey Hortorium)
Root, Richard B., Ph.D., U. of California at Berkeley. Prof., Ecology and Evolutionary Biology/Entomology
Rose, Jocelyn, Ph.D., U. of California at Davis. Asst. Prof., Plant Biology
Russell, James B., Ph.D., U. of California at Davis. Prof., Microbiology
Seeley, Jr., Harry W., Ph.D., Cornell U. Prof. Emeritus, Microbiology
Shalloway, David I., Ph.D., Massachusetts Inst. of Technology. Greater Philadelphia Prof., Molecular Biology and Genetics
Shapleigh, James P., Ph.D., U. of Georgia. Asst. Prof., Microbiology
Thiel, Daniel J., Ph.D., Cornell U. Asst. Prof., Molecular Biology and Genetics
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Uhl, Charles H., Ph.D., Cornell U. Prof. Emeritus, Plant Biology
Uhl, Natalie W., Ph.D., Cornell U. Prof. Emeritus, Plant Biology (Bailey Hortorium)
Van Wijk, Klaas J., Ph.D., Groningen U., The Netherlands. Asst. Prof., Plant Biology
Vogt, Volker M., Ph.D., Harvard U. Prof., Molecular Biology and Genetics
Walcott, Charles, Ph.D., Cornell U. Prof., Neurobiology and Behavior
Wayne, Randy O., Ph.D., U. of Massachusetts. Assoc. Prof., Plant Biology
Winans, Stephen C., Ph.D., Massachusetts Inst. of Technology. Assoc. Prof., Microbiology
Winkler, David W., Ph.D., U. of California at Berkeley. Prof., Ecology and Evolutionary Biology
Wu, Ray, Ph.D., U. of Pennsylvania. Prof., Molecular Biology and Genetics
Zahler, Stanley A., Ph.D., U. of Chicago. Prof. Emeritus, Molecular Biology and Genetics
Zinder, Stephen H., Ph.D., U. of Wisconsin. Prof., Microbiology

Other Teaching Personnel

Baustian, Mark D., Ph.D., Cornell U. Lecturer, Physiology
Blankenship, James E., M.S., Cornell U. Sr. Lecturer, Molecular Biology and Genetics
Calvo, Rita A., Ph.D., Cornell U. Sr. Lecturer, Molecular Biology and Genetics
Ecklund, P. Richard, Ph.D., Oregon State U. Sr. Lecturer, Neurobiology and Behavior
Ely, Susan, Ph.D., Tufts U. Lecturer, Molecular Biology and Genetics
Glase, Jon C., Ph.D., Cornell U. Sr. Lecturer, Neurobiology and Behavior
Land, Bruce, Ph.D., Cornell U. Sr. Lecturer, Neurobiology and Behavior*
McFadden, Carol H., Ph.D., Cornell U. Sr. Lecturer, Physiology
Merkel, Susan, M.S., Cornell U. Lecturer, Microbiology
Nivison, Helen T., Ph.D., U. of California at Davis. Lecturer, Molecular Biology and Genetics
Rehkugler, Carole M., M.S., Cornell U. Sr. Lecturer, Microbiology
Shulman, Myra J., Ph.D., U. of Washington. Sr. Res. Assoc., Ecology and Evolutionary Biology
Silva, Thomas, Ph.D., Cornell U. Lecturer, Plant Biology
Wrege, Peter H., Ph.D., Cornell U. Sr. Res. Assoc., Ecology and Evolutionary Biology

Joint Appointees

Bloom, Stephen E., Prof., Veterinary/ Microbiology and Immunology
Bradbury, Jack, Ph.D., Rockefeller. Prof., Neurobiology and Behavior/Library of Natural Sounds
Brutnell, Thomas, Prof., Plant Breeding/Plant Biology
Comstock, Jonathan P., Adjunct Assoc. Prof., Boyce Thompson Institute/Ecology and Evolutionary Biology
Foote, Robert H., Jacob Gould Schurman Prof. Emeritus, Animal Science/Physiology
Giovannoni, James G., Adjunct Asst. Prof., USDA Science and Education Administration/Plant Biology
Kochian, Leon V., Adjunct Prof., USDA Science and Education Administration/Plant Biology
Korf, Richard P., Prof. Emeritus, Plant Pathology/Plant Biology (Bailey Hortorium)
Kresovich, Stephen, Prof., Plant Breeding/ Plant Biology
Liebherr, James K., Assoc. Prof., Entomology/ Plant Biology (Bailey Hortorium)
Mason, Hugh S., Adjunct Asst. Prof., Boyce Thompson Institute/Plant Biology

McClure, Polley A., Prof., Information Technologies/Ecology and Evolutionary Biology
McCouch, Susan R., Assoc. Prof., Plant Breeding/Plant Biology
Pimentel, David, Prof. Emeritus, Entomology/Ecology and Evolutionary Biology
Rossman, Michael J., Adjunct Prof., Purdue U./Molecular Biology and Genetics
Stern, David B., Adjunct Prof., Boyce Thompson Institute/Plant Biology
Tanksley, Stephen, Prof., Plant Breeding/Liberty Hyde Bailey Prof., Plant Biology
Thompson, John F., Adjunct Prof., USDA Science and Education Administration/Plant Biology
Vehrencamp, Sandra, Ph.D., Cornell U. Prof., Neurobiology and Behavior/Library of Natural Sounds
Wheeler, Quentin D., Prof., Entomology/Plant Biology (Bailey Hortorium)

College of Arts and Sciences

Adkins-Regan, Elizabeth, Ph.D., U. of Pennsylvania. Prof., Neurobiology and Behavior/Psychology
Aquadro, Charles F., Ph.D., U. of Georgia. Prof., Molecular Biology and Genetics/Ecology and Evolutionary Biology
Bass, Andrew H., Ph.D., U. of Michigan. Prof., Neurobiology and Behavior
Blackler, Antonie W., Ph.D., U. of London (England). Prof., Molecular Biology and Genetics
Booker, Ronald, Ph.D., Princeton U. Assoc. Prof., Neurobiology and Behavior
Bretscher, Anthony P., Ph.D., Leeds U. (England). Prof., Molecular Biology and Genetics
Brown, William J., Ph.D., U. of Texas Health Science Center at Dallas. Prof., Molecular Biology and Genetics
Capranica, Robert R., Sc.D., Massachusetts Inst. of Technology. Prof. Emeritus, Neurobiology and Behavior
Chen, Rey-Huei, Ph.D., Harvard U. Asst. Prof., Molecular Biology and Genetics
Deitcher, David, Ph.D., Harvard Med. School. Asst. Prof., Neurobiology and Behavior
Ellner, Stephen P., Ph.D., Cornell U. Prof., Ecology and Evolutionary Biology
Feigenson, Gerald W., Ph.D., California Inst. of Technology. Prof., Molecular Biology and Genetics
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Greene, Harry W., Ph.D., U. of Tennessee. Prof., Ecology and Evolutionary Biology
Hairston, Nelson G., Jr., Ph.D., U. of Washington. Frank H. T. Rhodes Professor of Environmental Science, Ecology and Evolutionary Biology‡
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Heppel, Leon A., Ph.D., U. of California at Berkeley. Prof. Emeritus, Molecular Biology and Genetics
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Hinkle, Peter C., Ph.D., New York U. Prof., Molecular Biology and Genetics
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Leonard, Samuel L., Ph.D., U. of Wisconsin. Prof. Emeritus, Molecular Biology and Genetics
Linster, Christine, Ph.D., Pierre and Marie Curie U. Asst. Prof., Neurobiology and Behavior
McCobb, David, Ph.D., U. of Iowa. Asst. Prof., Neurobiology and Behavior
MacDonald, June M. Fessenden, Ph.D., Tufts U. Assoc. Prof. Emeritus, Molecular Biology and Genetics/Program on Science, Technology, and Society
McFarland, William N., Ph.D., U. of California at Los Angeles. Prof. Emeritus, Ecology and Evolutionary Biology
Nicholson, Linda, Ph.D., Florida State U. Asst. Prof., Molecular Biology and Genetics
Podleski, Thomas R., Ph.D., Columbia U. Prof. Emeritus, Neurobiology and Behavior
Power, Alison G., Ph.D., U. of Washington. Prof., Ecology and Evolutionary Biology/Science and Technology Studies
Provine, William B., Ph.D., U. of Chicago. Charles A. Alexander Professor of Biological Sciences, Ecology and Evolutionary Biology/History
Seeley, Thomas D., Ph.D., Harvard U. Prof., Neurobiology and Behavior
Sherman, Paul W., Ph.D., U. of Michigan. Prof., Neurobiology and Behavior
Sparks, Jed P., Ph.D., Washington State U. Asst. Prof., Ecology and Evolutionary Biology
Turgeon, Robert, Ph.D., Carleton U. (Canada). Prof., Plant Biology
Wallace, Bruce, Ph.D., Columbia U. Prof. Emeritus, Molecular Biology and Genetics
Whitlock, Kathleen E., Ph.D., U. Washington Seattle. Asst. Prof., Molecular Biology and Genetics
Wilson, David B., Ph.D., Stanford U. Prof., Biochemistry, Molecular Biology and Genetics
Wolfner, Mariana F., Ph.D., Stanford U. Prof., Molecular Biology and Genetics
Zamudio, Kelly R., Ph.D., U. of Washington. Asst. Prof., Ecology and Evolutionary Biology

Other Teaching Personnel

Eberhard, Carolyn, Ph.D., Boston U. Sr. Lecturer, Plant Biology
Johnson, Bruce R., Ph.D., Boston U. Sr. Lecturer, Neurobiology and Behavior

Joint Appointees

Levin, Simon A., Adjunct Prof., Princeton U./Ecology and Evolutionary Biology
Likens, Gene E., Adjunct Prof., Institute of Ecosystem Studies/Ecology and Evolutionary Biology

College of Veterinary Medicine

Gasteiger, Edgar L., Ph.D., U. of Minnesota. Prof. Emeritus, Physiology/Veterinary Physiology
Kotlikoff, Michael I., Ph.D., U. California at Davis. Prof., Veterinary Physiology/Physiology
Tapper, Daniel N., Ph.D., Cornell U. Prof. Emeritus, Physiology/Veterinary Physiology
Wasserman, Robert H., Ph.D., Cornell U. James Law Prof. Emeritus, Physiology/Veterinary Physiology/Nutritional Sciences*‡

Other Teaching Personnel

Concannon, Patrick W., Ph.D., Cornell U. Sr. Res. Assoc. Emeritus, Veterinary Physiology/Physiology

Joint Appointees

Fortune, Joanne E., Ph.D., Cornell U. Prof., Veterinary Physiology/Physiology
Gilmour, Robert F., Ph.D., SUNY Upstate Medical Center. Assoc. Prof., Veterinary Physiology/Physiology
Houpt, Katherine A., Prof., Veterinary Physiology/Physiology
Houpt, T. Richard, Prof., Veterinary Physiology/Physiology
Nathanielsz, Peter W., James Law Prof., Veterinary Physiology/Physiology
Robertshaw, David, Ph.D., Glasgow U. (Scotland). Prof., Veterinary Physiology/Physiology
Wootton, John F., Prof., Veterinary Physiology/Physiology

College of Engineering

Joint Appointees

Cisne, John L., Assoc. Prof., Geological Sciences/Biological Sciences
Webb, Watt W., Prof., Applied and Engineering Physics/Biological Sciences

Biological Sciences

Joint Appointees

Snedeker, Suzanne M., Asst. Prof., Center for the Environment/Biological Sciences

Division of Nutritional Sciences

Joint Appointees

Arion, William J., Prof., Nutritional Sciences/Molecular Biology and Genetics
Bensadoun, Andre, Prof., Nutritional Sciences/Physiology
Kazarinoff, Michael N., Assoc. Prof., Nutritional Sciences/Molecular Biology and Genetics
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