

## BIOLOGICAL SCIENCES

The biological sciences 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 foundational and integral to many other disciplines and serve as basic requirements in several programs, departments, and colleges at Cornell.

Graduate study in the biological sciences is administered by 30 specialized fields within the Graduate School, as described in the Fields of Study catalog at [www.gradschool.cornell.edu/index.php?p=38](http://www.gradschool.cornell.edu/index.php?p=38).

### ORGANIZATION

Many different departments across several undergraduate colleges at Cornell participate in the biological sciences major.

Student services are provided by the Office of Undergraduate Biology (OUB), [www.biology.cornell.edu](http://www.biology.cornell.edu). Located in Stimson Hall, the professional and student advisors provide academic and career advising, as well as help undergraduates find research opportunities on campus. Advisors in the OUB also follow the progress of biology majors and work closely with faculty advisors. Additional services and resources of the Biology Center include tutoring, 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 main administrative office in Stimson Hall provides academic advising for students interested in the marine sciences.

### 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. 7, *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 253–3523. 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

Advanced placement biology credits are not accepted for substitution or placement out of any requirement for the biological sciences major for students matriculating fall 2010 and afterward. For information on credit for advanced placement in biological sciences, see [www.biology.cornell.edu/advising/ap.html](http://www.biology.cornell.edu/advising/ap.html).

### THE MAJOR

The biological sciences major is available to students enrolled in either the College of Agriculture and Life Sciences or the College of Arts and Sciences. The program's curriculum, academic advising, and undergraduate research components are coordinated for students in both colleges by the Office of Undergraduate Biology.

Starting in fall 2010, a new curriculum will be implemented. Students majoring in biological sciences will no longer take a one-year introductory biology course sequence. Instead, students will take a set of six foundation courses in the core areas of biology. In the first three semesters biology majors will be expected to take Evolution and Diversity, Investigative Biology Laboratory, and two courses from three core "choice" areas of biology: Comparative Physiology, Cell and

Developmental Biology, and Ecology and the Environment. Two additional core courses, Genetics and Genomics and Biochemistry and Molecular Biology, are required of all biological sciences majors and are typically taken in the sophomore or junior years. The Investigative Biology Laboratory is a one-semester course, which will provide both basic laboratory skills and an introduction to the methodology of scientific research, including experimental design, Internet-based biology resource searches, statistics, and scientific writing. Additionally, majors will select one of 13 programs of study within the biological sciences major.

Whenever possible, students should include Evolution and Diversity, Investigative Biology Laboratory, one core choice course, general chemistry, and mathematics sequences in their freshman schedule. Genetics and Genomics should not be taken in the senior year. Students should work closely with their faculty advisor and staff advisors in the Office of Undergraduate Biology to design a suitable academic course plan. Sample course schedules can be found at [www.biology.cornell.edu](http://www.biology.cornell.edu). 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, 216 Stimson Hall.

As an alternative pathway into the biology major, students may take BIOG 1105–1106 Introductory Biology: Individualized Instruction. This course sequence takes the place of Comparative Physiology and the Investigative Biology Laboratory. Students who take this route will still need to complete one additional core course (Cell and Developmental Biology or Ecology and the Environment) as well as Evolution and Diversity, Genetics and Genomics, Biochemistry and Molecular Biology, and a program of study.

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 academic performance in core courses, particularly after the freshman year, may indicate a need to reevaluate aptitude and general interest in the major. Students with concerns about their ability to complete the major are encouraged to consult their biology advisor and to take advantage of the professional academic advising service available in the Office of Undergraduate Biology, as well as those offered by the student's college.

The requirements for the biological sciences major are listed below. Requirements 1–10 must be taken for a letter grade. Once matriculated, students are required to complete all major core requirements at Cornell or during an approved Study Abroad semester (numbers 1, 2, 7–9 below). Students must take all courses for the program of study for a letter grade unless the course is offered

for S-U grades only or if the student's advisor grants permission.

1. Two of three core "choice" courses: BIOG 1440 (Comparative Physiology), BIOMG/BIOG 1350 (Cell and Developmental Biology), BIOEE/BIOG 1610 (Ecology and the Environment)
2. Investigative Laboratory: BIOG 1500
3. General chemistry: CHEM 2070-2080 or 2150. Students who, via advanced placement, take only CHEM 2080 or only 2150 should be aware that some professional and graduate schools require 8 credits of general chemistry. These students may wish to take both CHEM 2150 and 2090 or 2150 and 2160. Students may wish to consult with their faculty advisor or advisors in the Office of Undergraduate Biology for further clarification.
4. College mathematics (one year); one semester of calculus (MATH 1106, 1110, or their equivalent) plus one semester selected from the following:
  - a. a second semester of calculus (MATH 1120, 1910, or equivalent).
  - b. a course in finite mathematics (MATH 1105).
  - c. a course in statistics (BTRY 3010, MATH 1710, AEM 2100, ILRST 2100, PSYCH 3500, PAM 2100, ECON 3190, ECON 3210, SOC 3010).
5. Organic chemistry: CHEM 1570 and 2510, or 3570-3580 and 2510, or 3570-3580 and 3010, or 3590-3600 and 2510, or 3590-3600 and 3010.
6. Physics: PHYS 1101-1102, 2207-2208, or 1112-2213. Those who take PHYS 1112-2213 are advised to complete PHYS 2214 as well.
7. Evolutionary Biology and Diversity: BIOEE/BIOG 1780.
8. Genetics and Genomics: BIOMG/BIOG 2810.
9. Biochemistry and Molecular Biology: BIOMG/BIOG 3300, 3330, 3350, or BIOMG 3310-3320. Note: BIOMG/BIOG 3350 is not recommended for those students concentrating in Biochemistry or Molecular and Cell Biology.
10. A program of study selected from the listing below.

#### Notes:

- \* Advanced placement biology credits are not accepted for substitution or placement out of any requirement for the biological sciences major.
- \* Because of extensive overlap in content, students may not earn credit for both BIOG 1105 and BIOG 1440.
- \* Although not required for the biological sciences major, a course in statistics is recommended for all biology students. Students should consult their faculty advisors when choosing appropriate courses in statistics.
- \* Core courses noted in numbers 1-9 above cannot count toward the program of study requirements.
- \* Transfer students who have taken a full year of introductory biology with

laboratory at another institution are required to complete one of three core choice courses listed in number 1 above.

- \* Transfer students who have taken advanced courses in biology in addition to a full year of introductory biology with a laboratory can elect to apply their advanced course toward the core choice course requirement (number 1 above) or apply it toward a program of study course requirement. Please see the advisors in Office of Undergraduate Biology for guidance.

#### Pre-medical/veterinary students not majoring in biological sciences

- Students may fulfill the pre-medical/veterinary introductory biology requirements by completing BIOG 1105-1106 or by taking two of the three core choice courses and the Introduction to Investigative Biology Laboratory, listed above in number 1 and number 2. An additional biology laboratory course is recommended.
- Advanced placement biology credits may still be used toward fulfilling pre-medical/pre-veterinary prerequisite courses, but students should check Cornell Career Services, 103 Barnes Hall, for the listing of medical schools that recognize AP credit.
- Non-biological sciences majors should consult with their major advisor for course selection advice regarding freshmen-level biology courses that may be required of their particular major.

#### 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 (POS). 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 advisor. Programs of study for particular subject areas are designed by faculty members 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 (3000 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 (BIOG 4990). The possible programs of study and their requirements are following:

1. **Animal Physiology:** BIOAP 3110 Introductory Animal Physiology, BIOAP 3160 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: ANSC 2400 Animal Reproduction and Development; ANSC

4100 Nutritional Physiology and Metabolism; ANSC 4270 Fundamentals of Endocrinology; BIOMS 3150 Basic Immunology; BIOAP 2140 Biological Basis of Sex Differences; BIOAP 4580 Mammalian Physiology; BIOAP 4750 Mechanisms Underlying Mammalian Developmental Defects; BIOAP 4890 Mammalian Embryology; BIOMG 4370 Regulation of Cell Proliferation, Senescence, and Death; BIOMG 3850 Developmental Biology; BIOMG 4000 A Genomics Approach to Studying Life; BIOMG 4010 Genomic Analysis; BIONB 3220 Hormones and Behavior; BIONB 3920 Drugs and the Brain; BIONB 4920 Sensory Function; NS 3310 Physiological and Biochemical Bases of Human Nutrition.

- b. Laboratory courses: BIOAP 4130 Histology: The Biology of the Tissues; BIOAP 3190 Animal Physiology Laboratory; BIOAP 4160 Cellular Physiology and Genomics Laboratory; BIOMG 4400 Laboratory in Biochemistry and Molecular Biology.
2. **Biochemistry:** Students electing this program of study should be sure to complete CHEM 2070-2080 or CHEM 2150-2160 during their freshman year. 6 credits of organic chemistry (CHEM 3570-3580 or CHEM 3590-3600); 5 credits of Biochemistry (either BIOMG 3310 and 3320, or BIOMG 3300 and 3340); BIOMG 4320 Survey of Cell Biology; BIOMG 4400 Laboratory in Biochemistry and Molecular Biology; physical chemistry (CHEM 2870-2880 or 3890-3900 or 3890-2880); and at least one other course with a biochemical or biophysical orientation selected from the following list: BIOMG 4380 RNA World; BIOMG 6310 Protein Structure, Dynamics, and Function; BIOMG 7300 Protein NMR Spectroscopy; CHEM 3000 Quantitative Chemistry; CHEM 4510 Structural Chemical Biology.

#### Notes:

- \* It is recommended that when selecting freshman-level core biology choice courses that one of them be BIOMG 1350 Principles of Cell and Developmental Biology.
  - \* Students interested in graduate work in biochemistry should take PHYS 2207-2208 and should consider taking CHEM 3890-3900 and its prerequisites.
  - \* Biology majors in the College of Agriculture and Life Sciences who select the biochemistry program of study are allowed to take up to 61 credit hours in the endowed colleges because of the high number of endowed courses required for this program.
3. **Computational Biology:** Computation has become essential to biological research. Genomic databases, protein databanks, MRI images of the human brain, and remote sensing data on landscapes contain unprecedented amounts of detailed information that is transforming almost all of biology. Problems investigated by computational biologists include topics as diverse as the genetics of disease susceptibility; comparing entire genomes to reveal the evolutionary history of life; predicting the

structure, motions, and interactions of proteins; designing new therapeutic drugs; modeling the complex signaling mechanisms within cells; predicting how ecosystems will respond to climate change; and designing recovery plans for endangered species. The computational biologist must have skills in mathematics, statistics, and the physical sciences as well as in biology. A key goal in training is to develop the ability to relate biological processes to computational models. Cornell faculty work primarily in four subareas of computational biology: biomolecular structure, bioinformatics and data mining, ecology and evolutionary biology, and statistical and computational methods for modeling biological systems.

Beyond core skills in mathematics, physical sciences, and biology, the computational biology program of study requires additional course work in mathematics and computer programming, a “bridging” course aimed at connecting biology to computation, and an advanced course where the theoretical/computational component of one aspect of biology is studied. Students should enroll in the more rigorous courses in the physical and mathematical sciences and may wish to take additional courses in these areas.

Computational biology has applications as broad as biology itself. The problems of interest and the tools available to study them are constantly evolving, so students are encouraged to gain fundamental skills that will serve them throughout their careers. There is great, and increasing, demand for research scientists and technical personnel who can bring mathematical and computational skills to the study of biological problems. The program is also an excellent preparation for graduate study in any area of biology or computational biology.

#### Required Courses for Program of Study in Computational Biology

- a. One course in computer programming (CS 1110, CS 1112, CS 1113, CS 1114) Introduction to Computer Programming, or BEE 1510 Introduction to Computer Programming.
- b. One additional course in mathematics (MATH 2210 Linear Algebra; or MATH 2310 Linear Algebra with Applications; or MATH 2940 Linear Algebra for Engineers; or MATH 4200 Differential Equations and Dynamical Systems; or BTRY 4070 Principles of Probability and Statistics; or BTRY 4080 Theory of Probability; or BTRY 4210 Matrix Computation).
- c. One of the following bridging courses, i.e., a course in mathematical modeling applied to biology:
  - BIOEE 3620 Dynamic Models in Biology
  - BIOEE 4600 Theoretical Ecology
  - BIONB 3300 Introduction to Computational Neuroscience
  - BTRY 4820 Statistical Genomics
  - BTRY 4830 Quantitative Genomics
  - BTRY 4840 Computational Genomics
  - NTRES 3100 Applied Population Ecology

NTRES 4110 Quantitative Ecology and Management of Fisheries Resources

- d. One course from the following list of advanced courses, or an additional “bridging” course numbered 4000 or above:
  - BIOMG 6310 Protein Structure and Function
  - BIOMG 4810 Population Genetics
  - BIOMG 4840 Molecular Evolution
  - BIOMG 4870 Human Genomics
  - BIONB 4220 Modeling Behavioral Evolution
  - BIOPL 4400 Phylogenetic Systematics
  - BTRY 4070 Principles of Probability and Statistics
  - BTRY 4080 Theory of Probability
  - BTRY 4090 Theory of Statistics
  - BTRY 4790 Probabilistic Graphical Models (also CS 4782)
  - BTRY 6520 Computationally Intensive Statistical Inference
  - CS 2110 Object-Oriented Programming and Data Structures
  - CS 4210 Numerical Analysis and Differential Equations
  - CS 4220 Numerical Analysis: Linear and Non-Linear Problems
  - MATH 4200 Differential Equations and Dynamical Systems
  - NTRES 4120 Wildlife Population Analysis: Techniques and Models
  - NTRES 6700 Spatial Statistics
  - ORIE 3500 Engineering Probability and Statistics II
  - ORIE 3510 Introductory Engineering Stochastic Processes

#### Notes:

1. Many of the “bridging” and “advanced” courses listed above (items 3 and 4) are offered only in alternate years or irregularly, and many have prerequisites that are not required for the biology major or this POS. Students therefore need to plan well in advance how they will satisfy these requirements, and verify when course offerings will occur.
  2. It is strongly recommended that students in this POS use PHYS 2207/2208 to satisfy the core physics requirement.
  3. It is strongly recommended that students complete the core organic chemistry requirement using the CHEM 1570/2510 option, and that the time saved be used to take either CS 2110 or a second mathematics course from the list above.
  4. MATH 2210 Linear Algebra, MATH 2310 Linear Algebra with Applications, or MATH 4200 Differential Equations and Dynamical Systems is recommended for bridging course BIOEE 4600.
  5. One course may not be used to satisfy two different requirements simultaneously. For example, BTRY 4080 can be used to satisfy either requirement (2) or requirement (4), but not both.
6. Students who use BTRY 4080 to fulfill the additional mathematics requirement should not use ORIE 3500 Engineering Probability and Statistics II to fulfill the requirement for an advanced course.
  7. 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/BIOG 1610 Ecology and the Environment. Students must also complete 10 credits from the following lists: (a) Principles, (b) Organisms, and (c) Ecological and Evolutionary Processes. One course must be chosen from list (a) and a second either from list (b) or (c). The remaining credits can be satisfied with courses from any of the three lists. Students are encouraged to take at least one course from each list.
    - a. Principles: BIOEE 4530 Speciation; BIOEE 4580 Community Ecology; BIOEE 4600 Theoretical Ecology; BIOEE 4640 Macroevolution; BIOEE 4800/ENTOM 4700 Ecological Genetics; BIOEE 4780 Ecosystem Biology; BIOMG 4810 Population Genetics; NTRES 3100 Applied Population Ecology.
    - b. Organisms: BIOEE 2740 The Vertebrates: Structure, Function, and Evolution; BIOEE 3730 Biodiversity and Biology of the Marine Invertebrates or BIOSM 3760 Marine Invertebrate Zoology; BIOEE 4500 and 4501 Mammalogy, lec and lab; BIOEE 4700 and 4701 Herpetology lec and lab; BIOEE 4750 Ornithology; BIOEE 4760 Biology of Fishes; ENTOM 2120 Insect Biology; BIOPL 2410 Introductory Botany; BIOPL 4480 Plant Evolution and the Fossil Record; PLPA 3090 Fungi; BIOSM 4490 Marine Botany.
    - c. Ecological and Evolutionary Processes: BIOEE 2630 Field Ecology; BIOEE 2650 Tropical Field Ecology and Behavior; NS/ANTHR 2750 Human Biology and Evolution; BIOEE/BIONB/ENTOM 3690 Chemical Ecology; BIOEE/EAS 3500 Dynamics of Marine Ecosystems; BIOEE/MATH 3620 Dynamic Models in Biology; BIOEE/BIONB 4460/4461 Plant Behavior—Induced Plant Responses to Biotic Stresses, lec and lab; BIOEE/ENTOM 4550 Insect Ecology; BIOEE/NTRES 4560 Stream Ecology; BIOEE 4570 and 4571 Limnology: Ecology of Lakes, lec and lab; BIOEE/EAS 4620 Marine Ecology; BIOEE 4660 and 4661 Physiological Plant Ecology, lec and lab; BIOEE/HORT 4730 Ecology of Agricultural Systems; NTRES 4200 Forest Ecology; BIOSM 4130 Research in Marine Biology; NTRES 4220 and 4221 Wetland Ecology, lec and lab; BIOMI 4180 Microbial Ecology; CSS/HORT 4660 Soil Ecology; BIOPL/ENTOM 4400 Phylogenetic Systematics; BIOPL 4470 Molecular Systematics; BIOPL/ENTOM 4530 Principles and Practice of Historical Biogeography;

BIOEE/EAS 4790 Paleobiology; BIOMG 4840 Molecular Evolution.

Note: Students also are encouraged to gain experience in some aspect of field biology through course work at a biological field station and can apply up to 6 credits in the place of courses from lists (b) or (c). For example, students may apply 6 credits from the following courses taken at the Shoals Marine Laboratory (BIOSM): BIOSM/BIOMI 3080 Field Microbial Ecology; BIOSM 3090 Coastal Ecology and Bioclimates; BIOSM 3210 Anatomy and Function of Marine Vertebrates; BIOSM 3740 Field Ornithology; BIOSM 3770 Diversity of Fishes; BIOSM 4770 Marine Vertebrates; and BIOSM courses in lists b and c. The Ecology and Evolutionary Biology program of study offers a specialization in Marine Biology and Oceanography (for a description, see "Courses in Marine Science"). The Organization for Tropical Studies (OTS) offers an Undergraduate Semester Abroad Program, featuring two courses (Fundamentals in Tropical Biology and Field Research in Tropical Biology) that can count as two 3-credit courses toward the concentration. Six credits can be applied from the 15-week fall "Semester in Environmental Science" program offered by the Woods Hole Marine Biological Laboratory.

5. **General Biology:** The program of study in general biology requires a minimum of 13 credit hours in addition to courses counted toward requirements 1-9 on pages 175-176. These 13 credits must include:
- 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 advisor.
  - A course with a laboratory.
  - A minimum of two upper-level (3000 and above) courses of 2 or more credits each.

1000-level courses are not acceptable for meeting any of these requirements. BIOG 4980 may not be used to fulfill the requirements of this program of study. BIOG 4990 (minimum of 2 credits, but no more than 3 credits) may count as one of the upper-level courses and may count as the laboratory course with approval of the advisor, but it cannot count as a course representing a program of study. Students must use three or more biological sciences courses to fulfill the requirements of this program of study.

**Note:** It is possible to use a single course to fulfill more than one requirement. For example, BIOAP 4130 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: BIOAP 4750 Mechanisms Underlying Mammalian Developmental Defects; BIOEE 4530

Speciation; BIOMG 3850 Developmental Biology; BIOMG 4000 Genomics; BIOMG 4010 Genomic Analysis; BIOMG 4340 Applications of Molecular Biology to Medicine, Agriculture, and Industry; BIOMG 4370 Regulation of Cell Proliferation, Senescence, and Death (also TOX 4370); BIOMG 4380 The RNA World; BIOMG 4450 Stem Cell Biology: Basic Science and Clinical Applications; BIOMG 4610 Development and Evolution (not offered 2010-2011); BIOMG 4810 Population Genetics; BIOMG 4825 Molecular Biology of Plant Organelles (also BIOPL 4825) (not offered 2010-2011); BIOMG 4831 Concepts and Techniques in Plant Molecular Biology (also BIOPL/PLPA/PLBR 4831); BIOMG 4834 Molecular Aspects of Plant Development I (also BIOPL 4834) (not offered 2010-2011); BIOMG 4840 Molecular Evolution; BIOMG 4850 Bacterial Genetics (also BIOMI 4850); BIOMG 4860 Eukaryotic Genetics; BIOMG 4870 Human Genomics; BIOMG 4890 Mammalian Embryology (also BIOAP/BIOMS 4890); BIOMG 4900 Manipulating the Mouse Genome (also NS 4900); BIOMG 6080 Epigenetics (also NS 6080); BIOMG 6100 Genomes as Chromosomes; BIOMS 6110 Genome Maintenance Mechanisms; BIOMG 6120 Overview of Model Genetic Organisms; BIOMG 6200 Evolutionary Genomics of Bacteria; BIOMG 6330 Biosynthesis of Macromolecules; BIOMG 6380 Filamentous Fungal Genomics and Development (also PLPA 6380); BIOMG 6390 The Nucleus; BIOMG 6410 Laboratory in Plant Molecular Biology (also BIOPL 6410); BIOMG 6870 Developmental Genetics; BIOMI 4200 Microbial Genomics; BIONB 4310 Genes and Behavior; BIONB 4930 Developmental Neurobiology; BIONB 4950 Molecular and Genetic Approaches to Neuroscience; BIOPL 3430 Molecular Biology and Genetic Engineering of Plants; BIOPL 4824 Plant Gene Evolution and Phylogeny; BIOPL 4826 Plant Biotechnology; BIOPL 4833 Plant Genome Organization and Function; BIOPL 4835 Molecular Breeding; PLBR 4030 Genetic Improvement of Crop Plants; PLBR 6060 Advanced Plant Genetics. Up to 3 credits for this program of study may be chosen from other biological sciences courses, including BIOG 4990 Independent Undergraduate Research in Biology, with approval from the faculty advisor.

7. **Insect Biology:** ENTOM 2120 Insect Biology plus a minimum of three additional courses totaling at least 9 credits selected from the following two groups. At least one of the three additional courses must be selected from group a.

**Group a:** ENTOM 3310 Insect Phylogeny and Evolution; ENTOM 3330 Larval Insect Biology; ENTOM 3520-3521 Medical and Veterinary Entomology plus lab; ENTOM 4440 Integrated Pest Management; ENTOM 4550 Insect Ecology; ENTOM 4630 Invertebrate Pathology; ENTOM 4830 Insect Physiology

**Group b:** ENTOM 3150 Spider Biology; ENTOM 3250 Insect Behavior; ENTOM 3440 Insect Conservation Biology; ENTOM 3690 Chemical Ecology; ENTOM 3070 Pesticides, Environment, and Human Health; ENTOM 4530 Principles and Practice of Historical Biogeography; ENTOM 4700 Ecological Genetics; ENTOM 4770 Biological Control; ENTOM 4900 Insect Toxicology

**Note:** Students in the Insect Biology program of study may not double major in entomology.

8. **Microbiology:** The program of study in microbiology requires a minimum of 13 credit hours in addition to the biology requirements. The introductory lecture and lab course, BIOMI 2900 General Microbiology Lecture and BIOMI 2911 General Microbiology Lab, ARE REQUIRED.

BIOMI 2900 General Microbiology Lecture  
BIOMI 2911 General Microbiology Laboratory

In addition, ONE of the Group A courses is ALSO REQUIRED. If desired, a student may take more than more than one of the Group A courses to fulfill the credit hour requirement.

**Group A:**

BIOMI 3910 Advanced Microbiology Laboratory

BIOMI 3970 Environmental Microbiology: Evolution, Biogeochemistry, Microbial Ecology

BIOMI 4140 Prokaryotic Diversity

BIOMI 4160 Bacterial Physiology

BIOMI 4200 Microbial Genomics

BIOMI 4850 Bacterial Genetics

Group B classes can be used to fulfill the credit-hour requirement but cannot be used to fulfill the Introductory or Group A course requirements:

**Group B:**

BIOMI 3210 The Normal Microbes of the Human Body in Health and Disease

BIOMI 3940 Applied and Food Microbiology

BIOMI 4040 Pathogenic Bacteriology and Mycology

BIOMI 4090 Principles of Virology

BIOMI 4310 Medical Parasitology

BIOMI 4480 Symbiotic Associations: Evolution and Ecology

VETMI 3290 Medical and Veterinary Mycology (also PLPA 3290)

9. **Molecular and Cell Biology:** Students electing this program of study should be sure to complete CHEM 2070-2080 or CHEM 2150-2160 during their freshman year. CHEM 3570-3580 or 3590-3600; 5 credits of biochemistry (either BIOMG 3310 and 3320, or BIOMG 3300 and 3340); BIOMG 4320 Survey of Cell Biology; BIOMG 4400 Laboratory in Biochemistry and Molecular Biology, or BIONB 4300 Experimental Molecular Neurobiology; and at least 7 additional credits of courses that have a cell biological or molecular biological orientation. The 7 additional hours should include at least two 2-credit or above courses from the following list: any BIOMG course at the 3000 level or

above (Note: graduate-level BIOMG courses are acceptable with permission of your advisor); BIOMS 3150 Basic Immunology; BIOMI 4090 Principles of Virology; BIOMI 4200 Microbial Genomics; BIOMI 4850 Bacterial Genetics; BIONB 4250 Molecular Neurophysiology; BIONB 4950 Molecular and Genetic Approaches to the Neurosciences; BIOPL 3420 Plant Physiology; BIOPL 3430 Molecular Biology and Genetic Engineering of Plants; BIOPL 4220 Plant Development; BIOPL 4440 Plant Cell Biology; BIOPL 4490 Green Signals and Triggers—The Plant Hormones; BIOPL 4620 Plant Biochemistry.

**Note:**

- \* It is recommended that when selecting freshman-level core biology choice courses that one of them be BIOMG 1350 Principles of Cell and Developmental Biology.
- 10. **Neurobiology and Behavior:** The two-semester introductory course sequence Neurobiology and Behavior I and II (BIONB 2210 and 2220) with discussion section (4 credits per semester), and 7 additional credits. The 7 additional credits must include at least one advanced BIONB course of 3 or more credits from the 3000 level or above. "Topics" courses (BIONB 4200s and 7200s), independent study (BIOG 4990), and PSYCH 4230 may be used toward the additional 7 credit requirement if taken for a letter grade, but do not qualify as advanced courses.

**Note:** Students who declare the program of study in Neurobiology and Behavior (NBB) after taking BIONB 2210 or 2220 for only 3 credits must still take the 1-credit discussion section in BIONB 2210 and 2220. To arrange this, the student should consult the professors in charge of the two courses.

**Recommendations:** The faculty of NBB strongly encourages students in NBB to: (1) gain laboratory or field experience in neurobiology or behavior by taking at least one laboratory course or field biology course given at a marine or field station, or by taking an independent research course for credit (BIOG 4990); (2) take at least one special topics (BIONB 4200) discussion course on a subject of interest as a capstone experience.

Some example lab/field courses are listed below:

Animal behavior and ecology: BIONB 3230 Methods in Animal Behavior, BIONB 4461 Plant Behavior Lab (also BIOEE 4461), BIOEE 2630 Field Ecology, BIOEE 3630 Field Methods in Ornithological Research, BIOEE 4701 Herpetology Laboratory, ENTOM 3311 Insect Phylogeny and Evolution Lab, NTRES 2100 Introductory Field Biology, NTRES 3111 Fish Ecology, NTRES 3141 Conservation of Birds Laboratory, BIOEE 2650 Tropical Field Ecology and Behavior, ENTOM 3150 Spider Biology.

Neurobiology and animal physiology: BIONB 3240 Biopsychology Laboratory (also PSYCH 3240), BIONB 4300 Experimental Molecular Neurobiology, BIONB 4440 Neural Computation (also PSYCH 4440), BIONB 4910 Principles of

Neurophysiology (also BME 4910), BIOAP 4160 Cell Physiology and Genomics, BIOMG 4400 Laboratory in Biochemistry and Molecular Biology, BIOAP 3190 Animal Physiology Experimentation, ENTOM 4830 Insect Physiology.

Field biology courses offered at Shoals Marine Lab: BIOSM 1110 A Marine Approach to Introductory Biology, BIOSM 3120 Biology of the Lobster, BIOSM 3210 Anatomy and Function of Marine Vertebrates, BIOSM 3290 Ecology of Animal Behavior, BIOSM 3740 Field Ornithology, BIOSM 3750 Field Marine Biology and Ecology, BIOSM 4130 Research in Marine Biology, BIOSM 4650 The Biology, Evolution, and Conservation of Sharks and Their Allies.

- 11. **Nutrition:** NS 3310 Physiological and Biochemical Bases of Human Nutrition (4 credits) and at least 9 credits of additional course work in the biological aspects of nutrition, such as NS 1220 Nutrition and the Life Cycle; NS 3150 Obesity and the Regulation of Body Weight; NS 3220 Maternal and Child Nutrition; NS 3320 Methods in Nutritional Sciences; NS 3410 Human Anatomy and Physiology; NS 3470 Human Growth and Development; NS 4310 Nutritional Genomics—Evolution and Environment; NS 4410 Nutrition and Disease; NS 4900 Manipulating the Mouse Genome; NS 6080 Epigenetics; NS 6100 Proteins and Amino Acids: Nutritional Regulation; NS 6110 Molecular Toxicology; NS 6140 Topics in Maternal and Child Nutrition; NS 6310 Micronutrients: Function, Homeostasis, and Assessment; and NS 6320 Regulation of Macronutrient Metabolism. Check [www.biology.cornell.edu/academics/nutrition.html](http://www.biology.cornell.edu/academics/nutrition.html) for a complete list.

**Note:** For students in the College of Agriculture and Life Sciences, credits in NS courses count toward the required 55 CALS credits. For students in the College of Arts and Sciences, NS credits 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 BIOPL 2410 Introductory Botany. Students should then choose, with the aid of their faculty advisor, a minimum of three of the following courses, for a total of at least 10 additional credits, to round out their botanical training: BIOEE 4660 and 4661 Physiological Plant Ecology, Lec and Lab; BIOPL 2420 and 2421 Plant Function and Growth, Lec and Lab; BIOPL 2430 Taxonomy of Cultivated Plants; BIOPL 2450 Plant Biology; BIOPL 2470 Plants and People; BIOPL 2480 Vascular Plant Systematics; BIOPL 3420 and 3421 Plant Physiology, Lec and Lab; BIOPL 3430 and 3431 Molecular Biology and Genetic Engineering of Plants, Lec and Lab; BIOPL 3450 Plant Anatomy; BIOPL 3480 The Healing Forest; BIOPL 3590 Biology of Grasses; BIOPL 3800 Strategies and Methods in Drug Discovery; BIOPL 4040 Crop Evolution, Domestication, and Diversity; BIOPL 4220 Plant Development; BIOPL 4400 Phylogenetic Systematics; BIOPL 4420 Current Topics in Ethnobiology; BIOPL 4440 Plant Cell Biology; BIOPL 4470

Molecular Systematics; BIOPL 4480 Plant Evolution and the Fossil Record; BIOPL 4490 Green Signals and Triggers—The Plant Hormones; BIOPL 4520/4521 Systematics of Tropical Plants and Field Lab; BIOPL 4530 Principles and Practice of Historical Biogeography; BIOPL 4620 Plant Biochemistry.

Option (b) Plant Biotechnology: Students are required to take BIOPL 3430 and 3431 Molecular Biology and Genetic Engineering of Plants, Lec and Lab. Students choose, in consultation with their faculty advisor, a minimum of 10 additional credits from the following list: BIOEE 4460 Plant Behavior—Induced Plant Responses to Biotic Stresses; BIOEE 4461 Plant Behavior—Induced Plant Responses to Biotic Stresses, Lab; BIOPL 2410 Introductory Botany; BIOPL 2420 and 2421 Plant Function and Growth, Lec and Lab; BIOPL 3420 and 3421 Plant Physiology, Lec and Lab; BIOPL 3800 Strategies and Methods in Drug Discovery; BIOPL 4220 Plant Development; BIOPL 4440 Plant Cell Biology; BIOPL 4470 Molecular Systematics; BIOPL 4490 Green Signals and Triggers—The Plant Hormones; BIOPL 4620 Plant Biochemistry; courses in the 482x and 483x module series, as follows (note that BIOPL 4831 is a prerequisite for all other courses in this series); BIOPL 4821 Molecular Plant-Pathogen Interactions I; BIOPL 4822 Molecular Plant-Pathogen Interactions II; BIOPL 4823 Molecular Plant-Microbe Interactions; BIOPL 4824 Plant Gene Evolution and Phylogeny; BIOPL 4825 Molecular Biology of Plant Organelles; BIOPL 4826 Plant Biotechnology; BIOPL 4827 Plant Cell Walls: Structure to Proteome; BIOPL 4828 Plant Imaging; BIOPL 4829 Light Signal Transduction in Plants; BIOPL 4831 Concepts and Techniques in Plant Molecular Biology; BIOPL 4832 Proteomics in Plant Biology; BIOPL 4833 Plant Genome Organization and Function; BIOPL 4834 Molecular Aspects of Plant Development; BIOPL 4835 Molecular Breeding; BIOPL 4836 Plant Senescence; PLBR 4010 Plant Cell and Tissue Culture; PLBR 4011 Plant Tissue Culture Laboratory; PLBR 4030 Genetic Improvement of Crop Plants; PLBR 4070 Nutritional Quality Improvement of Food Crops; or PLPA 4190 Agricultural Application of Plant Disease Concepts.

- 13. **Systematics and Biotic Diversity:** A minimum of 13 credits from the following two groups, including at least 7 credits from group a and 3 from group b and at least two laboratory courses (marked with \*). BIOG 4990 Independent Undergraduate Research in Biology, with approval of the advisor, can be used in fulfillment of up to 4 credits in group (a) and can count as one laboratory course if it has a laboratory component of 2 or more credits.
  - a. \*BIOEE 2640 Tropical Field Ornithology; \*BIOEE 2740 The Vertebrates: Structure, Function, and Evolution; BIOEE 3710 Human Paleontology; \*BIOEE 3730 Biology of the Marine Invertebrates; BIOEE 4500 Mammalogy, Lec; \*BIOEE 4501 Mammalogy, Laboratory; BIOEE 4700 Herpetology, Lec; \*BIOEE 4701

Herpetology, Lab; \*BIOEE 4750 Ornithology; \*BIOEE 4760 Biology of Fishes; BIOEE 4770 Marine Invertebrates Seminar; BIOMI 2900 General Microbiology, Lec; \*BIOMI 2910 General Microbiology, Lab; \*BIOMI 2911 General Microbiology Lab; BIOMI 3310 General Parasitology; BIOMI 4140 Prokaryotic Diversity, Lec; \*BIOPL 2410 Introductory Botany; \*BIOPL 2430 Taxonomy of Cultivated Plants; \*BIOPL 2450 Plant Biology; BIOPL 2470 Plants and People; \*BIOPL 2480 Vascular Plant Systematics; BIOPL 3480 The Healing Forest; BIOPL 3590 Biology of Grasses; BIOPL 4520 Systematics of Tropical Plants; \*BIOPL 4521 Systematics of Tropical Plants: Field Laboratory; \*ENTOM 2120 Insect Biology; ENTOM 2150 Spider Biology: Life on a Silken Thread; ENTOM 3150 Spider Biology; ENTOM 3310 Insect Phylogeny and Evolution; \*ENTOM 3311 Insect Phylogeny and Evolution Laboratory; \*ENTOM 3330 Maggots, Grubs, and Cutworms: Larval Insect Biology; PLPA 3090 Fungi; \*PLPA 3190 Mushrooms of Field and Forest.

- b. BIOEE 4530 Speciation; BIOEE 4640 Macroevolution; BIOEE 4790 Paleobiology; \*BIOPL 4400 Phylogenetic Systematics; BIOPL 4470 Molecular Systematics; \*BIOPL 4480 Plant Evolution and the Fossil Record; \*BIOPL 4530 Principles and Practices of Historical Biogeography.

### The Minor in Biological Sciences

The minor in biological sciences has been designed to provide students with a broad background in biology while allowing them some flexibility to choose courses of interest. Students must have completed one full year of college-level biology (or its equivalent) to declare the minor. Students will complete 12 to 15 credits by taking either all three biology core course requirements listed below or two of the biology core course requirements and 5 or more biology credits from the lists of approved program of study courses (with a "BIO" prefix) or other courses of significant biology content with the approval of the director of advising in the Office of Undergraduate Biology.

Biology core courses

1. Biochemistry: BIOMG 3300, 3310-3320, 3330, or 3350; one year of general chemistry and organic chemistry lecture (CHEM 1570 or 3570-3580) are prerequisites
2. Evolutionary biology and diversity: BIOEE 1780
3. Genetics and genomics: BIOMG 2810

\*BIOG 4990 Independent Research may not be used to fulfill any requirement for the minor. No course substitutions are allowed. With the exception of transfer and study abroad students, no biology courses taken at other institutions will count toward the minor.

### Notes:

- External transfer students must complete the core biology courses at Cornell. Students who are fulfilling the minor requirements under Option 2 must complete a minimum of one program of study course of at least 3 credits at Cornell.

- All courses for the minor must be taken for a letter grade unless a course is offered S-U only.
- Applications for the minor are located in 216 Stimson Hall and on the OUB web site. See Bonnie Comella, Jeff McCaffrey, or Wendy Aquadro for academic advising and for certifying completion of the minor.

### 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 beginning research should contact faculty members who have compatible research interests. Information about faculty research interests and undergraduate research opportunities is available in the Office of Undergraduate Biology, 216 Stimson Hall, and at [www.biology.cornell.edu/research](http://www.biology.cornell.edu/research).

Faculty members may consider the student's previous academic accomplishments, interests and career goals, and the availability of space and equipment when agreeing to supervise a student in their laboratory. Students conducting research for the first time must enroll in BIOG 2990, an S-U course designed to introduce students to research. After the first semester, students enroll in BIOG 4990. Registration for both of these classes is done in the Office of Undergraduate Biology in 216 Stimson Hall. Students may work with faculty in any department on campus as long as the research topic is biological. Students may not earn credit for research done off campus, unless supervised by a Cornell faculty member. Up to 3 credits of research may be used to complete the programs of study in general biology, genetics and development, as well as 4 credits in neurobiology and behavior and systematic and biotic diversity.

The honors program in biological sciences is designed to offer advanced training in life science research through the performance of an original research project under the direct guidance of a member of the Cornell faculty. Biology majors planning on graduating with honors must apply to the Biology Honors Program in the spring of their junior year. Applications and information are available in the Office of Undergraduate Biology, 216 Stimson Hall, or at [www.biology.cornell.edu/research/honors.html](http://www.biology.cornell.edu/research/honors.html). 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 Cornell grade point average (GPA) of at least 3.0. In addition, students must have at least a 3.0 cumulative Cornell GPA 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 to supervise their research. An honors candidate usually enrolls for credit in BIOG 4990 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 their senior year; submit an acceptable honors thesis; complete all major requirements; and maintain a 3.0 Cornell cumulative and science GPA

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 GPA and quality of his or her thesis are factors 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 at Cornell engaged in full-time research on their honors project.

Biology majors who are considering study abroad and graduating with honors are encouraged to meet with their academic and research advisor 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, and at [www.biology.cornell.edu](http://www.biology.cornell.edu).

### 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 members and welcomes advice and suggestions from all interested parties. The committee can be reached through the Office of Undergraduate Biology, 216 Stimson Hall.

### ADVISING

Students in need of academic advice are encouraged to consult their advisors or see an academic advisor in 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 Biology and Society major should see pages 507-514 in the College of Arts and Sciences section of this catalog.

### TRANSFERRING CREDIT

Biology majors are required to complete all three biology core courses (biochemistry, evolution, and genetics) at Cornell.

External transfer students are limited to transferring one core biology course and one course of up to 3 credits toward their program of study. See the Office of Undergraduate Biology for approval procedures.

Students who matriculated to Cornell as freshmen and Study Abroad students may transfer program of study courses at the discretion of their advisor. Study Abroad students must obtain approval from the Office of Undergraduate Biology, Director of Advising, to transfer biology core courses.

Online course credit is not acceptable to transfer for any biology course.

## GENERAL COURSES (BIOG)

**BIOG 1105–1106 Introductory Biology, Individualized Instruction**

1105, fall; 1106, spring. 4 credits each semester; 2 credits by permission of instructor. Taking 1105–1106 in sequence preferred but not required. No admittance after first week of classes. Because of extensive overlap in content, students may not receive credit for both BIOG 1105 and BIOG 1440. First lec of fall semester R Aug. 26, 9:05; additional study and lab. D. Campbell.

Designed primarily for pre-medical/veterinary life sciences majors and other students who desire a challenging, broad introduction to fundamental concepts of biology. Cell biology, physiology, anatomy, and biochemistry are strongly emphasized in BIOG 1105. BIOG 1106 covers genetics, development, ecology, evolution, behavior, and the diversity of organisms. Because some testing involves the use of pre-dissected specimens, students who object to dissections should take the relevant biology core choice courses and investigative lab. The course is based on individualized instruction 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. Web site: [www.biog1105-1106.org](http://www.biog1105-1106.org).

**BIOG 1140 Foundations of Biology**

Fall. 4 credits. Prerequisite: none. S-U or letter grades. E. R. Turgeon and M. Scanlon.

The course offers an introduction to biology at the cellular and molecular levels of biology that cover the chemical and cellular basis of life, including functional aspects of physiology, development, and genetics. The emphasis will be on key concepts that underlie living systems, rather than a myriad of unrelated facts. This is a lecture course that will have an integrated discussion section in which active-learning and student engagement activities further emphasize the key concepts with compelling examples from living systems. Designed to meet the biology requirements of science students who need to fulfill the distribution requirement in CALS and Human Ecology. It does not meet the requirement for the premedical or prevet program nor the major in biological science. It, along with courses in the core major program, may be used to fulfill the Arts and Sciences distribution requirement. There is no laboratory for this course. Students that require a biology laboratory experience as part of their requirements should enroll in BIOG 1500 Investigative Biology Laboratory.

**BIOG 1200 Biology Scholars Program Freshman Seminar**

Spring. 1 credit. Prerequisite: membership in Biology Scholars Program. S-U grades only. J. McCaffrey and J. J. Doyle.

This course is designed to help freshman biology majors make the transition to Cornell's science courses, give exposure to career options in research and medicine, provide opportunities to meet and network with faculty, and to facilitate students' pursuit of research on campus.

**BIOG 1250 Biology Seminar**

Fall and spring. 1–2 credits. Prerequisite: none. Staff.

A first-year seminar designed for students with a strong interest in research. Students will interact with faculty while learning to read and evaluate scientific publications on current biological topics. Multiple topics and sections will be offered each semester.

**BIOG 1350 Principles of Cell and Developmental Biology (also BIOMG 1350)**

Fall, spring, summer. 3 credits. Prerequisite: none. S-U or letter grades. Lec, disc. A. Bretscher, M. Garcia-Garcia, T. Huffaker, and K. Kemphues.

For description, see BIOMG 1350.

**BIOG 1440 Introduction to Comparative Physiology**

Fall, spring, summer. 3 credits. Prerequisite: none. S-U or letter grades; biological sciences majors must take course for a letter grade. Because of extensive overlap in content, students may not receive credit for both BIOG 1440 and BIOG 1105. Fall: E. Loew and T. Owens; spring: R. Booker and T. Seeley.

An introductory physiology course intended for freshman and sophomore biology majors. The course integrates physiology from the cell to the organism with comparisons among animals, plants and microbes. Emphasis is on understanding of basic physiological concepts, stressing structure-function relationships and underlying physio-chemical mechanisms.

**BIOG 1500 Investigative Biology Laboratory**

Fall, spring, summer. 2 credits. Prerequisite: none. S-U or letter grades; biological sciences majors must take course for a letter grade. D. Deitcher, K.-C. Chen, and L. Hester.

Designed for biology majors to provide lab experience with emphasis on processes of scientific investigations and to promote collaboration, communication, and literacy in science. Students gain expertise in methods including instrumentation used by biologists to construct new knowledge. Lab topics include physiology, genetics, evolution, ecology, biochemistry, and molecular biology.

**BIOG 1610 Ecology and the Environment (also BIOEE 1610)**

Fall, spring, summer. 3 or 4 credits. Prerequisite: none. S-U or letter grades. Fall: A. Flecker and C. Goodale; spring: R. Howarth and A. Kessler.

For description, see BIOEE 1610.

**BIOG 1780 Evolutionary Biology and Diversity (also BIOEE 1780)**

Fall, spring. 4 or 5 credits. Prerequisite: none. S-U or letter grades. R. Harrison, K. Zamudio, and I. Lovette.

For description, see BIOEE 1780.

**BIOG 2000 Special Studies in Biology**

Fall, spring, or summer. 1–3 credits. Prerequisite: written permission from Office of Undergraduate Biology. Students must register in 216 Stimson Hall. S-U or letter grades by permission of instructor. Staff.

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 1000-level courses and may not be used to fulfill college distribution requirements except by permission from the Office of Undergraduate Biology.

**BIOG 2200 Biology Scholars Program Sophomore Seminar**

Fall. 1 credit. Prerequisite: membership in Biology Scholars Program. S-U grades only. J. McCaffrey and J. J. Doyle.

The first half of the semester will focus on interpreting and evaluating scientific literature. Students will do group presentations on a primary research or review paper. The second half will cover careers in science, personal and professional development, on-campus research, and summer opportunities.

**BIOG 2810 Genetics and Genomics (also BIOMG 2810)**

Fall, spring, summer (eight-week sessions). 5 credits. Prerequisite: BIOG 1500 recommended. S-U or letter grades. Evening prelims. T. Fox, M. Goldberg, D. Nero.

For description, see BIOMG 2810.

**BIOG 2990 Introduction to Research Methods in Biology**

Fall, spring, or summer. Variable credit; max. 3 suggested. S-U grades only. Students must register for credit in Office of Undergraduate Biology, 216 Stimson Hall. Applications available in OUB and at [www.bio.cornell.edu](http://www.bio.cornell.edu). **Add deadline is three days before the university deadline.** Any Cornell faculty member whose research field is biological in nature may serve as a supervisor for this course. Non-Cornell supervisors not acceptable.

Intended for students who are new to undergraduate research. Students enrolled in BIOG 2990 may be reading scientific literature, learning research techniques, or assisting with ongoing research. The faculty supervisor determines the work goals and the form of the final report.

**BIOG 3010–3020 Seminar in Research Skills for Biologists: I and II**

Fall, spring. 1 credit per semester. Prerequisite: permission of instructor. Priority given to Biology Research Fellows. M. Shulman.

Designed for juniors, these courses develop skills used in all fields of biological research. Fall semester (I) researching the primary literature; critiquing scientific papers; facility with spreadsheet and bibliographic software. Spring semester (II): experimental design; data management and analysis; writing research proposals. Courses may be taken out of sequence.

**BIOG 3300 Principles of Biochemistry, Individualized Instruction (also BIOMG 3300)**

Fall or spring. 4 credits. Prerequisites: one majors-level biology course and one year general chemistry and CHEM 1570 or 3570–3580 (CHEM 3580 may be taken concurrently) or equivalent, or permission of instructor. S-U or letter grades. Recommended: concurrent registration in BIOMG 3340. May not be taken for credit after BIOMG 3310, 3320, 3330, or 3350. S-U or letter grades. Evening prelims: fall, Sept. 30 and Nov. 2; spring, Feb. 24 and April 5. J. Blankenship, P. Hinkle, Y. Mao, and staff.

For description, see BIOMG 3300.

**BIOG 3330 Principles of Biochemistry: Proteins, Metabolism, and Molecular Biology (also BIOMG 3330)**

Summer, six-week session. 4 credits.

Prerequisites: one majors-level biology course and one year general chemistry, and CHEM 1570, or 3570-3580, or equivalents, or permission of instructor. S-U or letter grades. May not be taken for credit after BIOMG 3300, 3310, 3320, or 3350. S. Ely and H. Nivison.

For description, see BIOMG 3330.

**BIOG 3350 Principles of Biochemistry: Proteins, Metabolism, and Molecular Biology (also BIOMG 3350)**

Spring. 4 credits. Prerequisite: one majors-level biology course and one year general chemistry, and CHEM 1570, or 3570-3580, or equivalents, or permission of instructor. CHEM 3580 may be taken concurrently. S-U or letter grades. May not be taken for credit after BIOMG 3300, 3310, 3320, or 3330. Lec and disc. B. Tye and C. Fromme.

For description, see BIOMG 3350.

**BIOG 4000 Undergraduate Seminar in Biology**

Fall or spring. Variable credit; 1-3 assigned for individual seminar offerings; participation in Weill Cornell Medical College in Qatar required. S-U or letter grades. Staff.

Specialized seminars on topics of interest to undergraduates studying at Weill Cornell Medical College in Qatar.

**BIOG 4040 Planning for Graduate Study in Biology**

Fall. 1 credit. S-U grades only. L. Southard. For students who plan to pursue a graduate degree leading to a research career. Selected topics include information on academic and industrial research careers, selecting appropriate graduate programs, and options for funding. Features faculty, graduate student, and outside speakers. Students write and receive feedback on personal statements.

**BIOG 4080 Presentation Skills for Biologists**

Spring. 1 credit. Prerequisite: research experience. Priority given to students accepted into Biology Honors Program. S-U grades only. L. Southard.

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

**BIOG 4100 Teaching High School Biology**

Fall. 3 credits. Prerequisite: one year introductory biology; permission of instructor. S-U or letter grades. Offered alternate years. L. Southard.

Gives students the opportunity to experience teaching high school science. Students select an important biological concept, then develop inquiry-based 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. Students then work in teams with high school teachers to develop their curriculum. The final part of the course includes practice presentations and teaching at regional high schools.

**BIOG 4940 Special Topics in Biological Sciences**

Fall or spring. 1-4 credits, variable. S-U or letter grades.

Biological Sciences offers "trial" courses or seminars under this number. Offerings vary by semester and are advertised by the department before the semester starts. Courses offered under this number will be approved by the Biological Sciences Curriculum Committee, and the same course is not to be offered more than twice under this number.

**BIOG 4980 Teaching Experience**

Fall or spring. 1-4 credits. Limited enrollment. Prerequisite: previous enrollment in course to be taught or equivalent. Note: Arts students may not count this course toward graduation but may, 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 or letter grades by 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.

**BIOG 4990 Independent Undergraduate Research in Biology**

Fall, spring, or summer. Variable credit. S-U or letter grades. Note: Arts students may not register for more than 6 credits per semester with one supervisor or 8 credits per semester with more than one supervisor. Students in CALS may use up to 15 credits of independent study (BIOG 4990, 4980) toward graduation. Up to 3 credits of research may be used to complete programs of study in General Biology, Genetics and Development, and Systematics and Biotic Diversity, and 4 credits of research in Neurobiology and Behavior. Prerequisite: one semester BIOG 2990 or equivalent or permission of instructor and Office of Undergraduate Biology.

For students with previous undergraduate experience conducting biological research at Cornell. Students enrolled for this credit should be doing independent work on their own project. Registration forms are available in OUB and on the web at [www.bio.cornell.edu](http://www.bio.cornell.edu). **Add deadline is three days before university deadline.** Each student must submit proposed research project description during course registration. Any Cornell faculty member whose research field is biological in nature may serve as supervisor for this course. Non-Cornell supervisors not acceptable.

**BIOG 6000 Graduate Seminar in Biology**

Fall or spring. Variable credit (1-3 credits assigned for individual seminar offerings); may be repeated for credit. S-U or letter grades. Staff.

Specialized seminars on topics of interest to graduate students presented by biology faculty including visiting faculty.

**Other Introductory Biology Courses for Non-Biological Sciences Majors**

The courses listed below are intended primarily for non-biological sciences majors. Please see the full course description for more

details. A complete list of all life sciences courses for non-life sciences students can be found under "quick links" at [www.cals.cornell.edu/cals/current/registrar/current-students/cals-graduation/nonlifefbiology.cfm](http://www.cals.cornell.edu/cals/current/registrar/current-students/cals-graduation/nonlifefbiology.cfm).

BIOPL 1120 Issues in Social Biology: From Diet to Disease, DNA to Deforestation

BIOPL 2400 Green World/Blue Planet

BIOPL 2410 Introductory Botany

BIOPL 2470 Plants and People

BIOPL 2490 Hollywood Biology: Science in Cinema

BIOG 1140 Foundations of Biology

CSS/BIOMI 1120 Microbes, the Earth, and Everything

**ANIMAL PHYSIOLOGY (BIOAP)****BIOAP 1250 Biology Seminar**

Fall and spring. 1-2 credits. Prerequisite: none. S-U grades only. Staff.

A first-year seminar designed for students with a strong interest in research. Students will interact with faculty while learning to read and evaluate scientific publications on current biological topics. Multiple topics and sections will be offered each semester.

**BIOAP 2140 The Biological Basis of Sex Differences (also BSOC 2141, BIOMS/FGSS 2140)**

Fall. 3 credits. Prerequisite: one college-level biology course or permission of instructor. S-U or letter grades. Offered alternate years. J. E. Fortune.

Examines the structural and functional differences between the sexes. Emphasizes 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 3110 Introductory Animal Physiology (also BIOMS 3110, VTBMS 3460)**

Fall. 3 credits. Prerequisites: BIOG 1500 Investigative Biology Laboratory and BIOG 1440 Comparative Physiology or one year of college biology; one year chemistry and mathematics or equivalent AP credit. Recommended: previous or concurrent physics course. S-U or letter grades by permission of instructor. Evening prelims. E. R. Loew.

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 3160 Cellular Physiology (also BIOMS 3160)**

Spring. 3 credits. Pre- or corequisite: BIOMG 1350 Principles of Cell and Developmental Biology or BIOMG 3300 or 3310 and 3320 or 3330. Letter grades only. Evening prelims. A. Quaroni.

A comprehensive course covering the general characteristics of eukaryotic 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, stem cells, apoptosis, and carcinogenesis.

**BIOAP 3190 Animal Physiology Experimentation (also BIOMS 3190)**

Fall. 4 credits. Pre- or corequisite: BIOAP 3110. For pre-med, pre-vet juniors and seniors and graduate students interested in biomedical science. Letter grades only.

E. R. Loew, N. A. Lorr, and staff.

Student-conducted in vitro and in vivo experiments designed to illustrate basic physiological processes, physiological research techniques, instrumentation, experimental design, and interpretation of results. Techniques include anesthesia, surgical procedures, dissection, and real-time computer recording and analysis. Experiments with isolated living tissues or live anesthetized animals examine properties of membranes and epithelia, blood, nerves, skeletal and smooth muscle; cardiovascular, respiratory, renal, and reproductive function and their regulation by the nervous and endocrine systems.

**BIOAP 4130 Histology: The Biology of the Tissues (also BIOMS 4130)**

Spring. 4 credits. Prerequisite: BIOMG 1350 Principles of Cell and Developmental Biology. Recommended: BIOMG 3300 or 3310, or equivalent. S-U or letter grades. S. Suarez and 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. Emphasizes dynamic interrelations of structure, composition, and function in cells and tissues.

**BIOAP 4160 Cell Physiology and Genomics Laboratory (also BIOMS 4160)**

Spring. 4 credits. Limited to 24 students. Pre- or corequisite: BIOAP 3160 or BIOMG 4320 or permission of instructor OR BIOMG 1350 is sufficient as a prerequisite. For pre-med, pre-vet, juniors, seniors, and graduate students interested in biomedical science. Letter grades only. H.-H. Chuang, N. A. Lorr, and staff.

The course emphasizes the application of molecular biology and analytical methods, including microscopy, to investigation of physiological mechanisms of cellular excitability. Students learn manipulation of nucleic acids including molecular cloning RT-PCR, qRT-PCR and microarray analysis, heterologous expression systems including *Xenopus* oocytes and cultured mammalian cells, characterization of proteins using antibodies, and analysis of ion channels, receptors, and signal transduction pathways by measuring ionic currents and membrane potentials in the *Xenopus* oocyte expression system. Students also learn critical reading of original research articles. Students will conduct an independent project in the latter part of the semester using methods and systems introduced during the course.

**[BIOAP 4250 Gamete Physiology and Fertilization (also ANSC 4250)]**

Fall. 2 credits. Prerequisite: ANSC 2400 or equivalent. Letter grades only. Offered alternate years; next offered 2011–2012.

Lec. J. E. Parks.

For description, see ANSC 4250.]

**BIOAP 4270 Fundamentals of Endocrinology (also ANSC 4270)**

Fall. 3 credits. Prerequisite: animal or human physiology course or permission of instructor. Letter grades only. Lec.

P. A. Johnson.

For description, see ANSC 4270.

**BIOAP 4580 Mammalian Physiology (also BIOMS 4580)**

Spring. 3 credits. Auditors allowed. Prerequisite: BIOAP 3110 or BIOG 1440 Comparative Physiology with permission of instructor. Recommended for biological sciences majors, pre-med and pre-vet students, and beginning graduate students in physiology, nutrition, and animal science. Letter grades only. Evening prelims. K. W. Beyenbach.

The course offers a treatment of selected topics in human physiology that emphasizes concepts and a working knowledge of physiology. The first course half surveys biological design and the functional strategies of multicellular animals. Topics include mammalian fluid compartments, homeostasis, and membrane and epithelial transport. The second half examines the mechanism and the regulation of cardiovascular, gastrointestinal, and renal systems. Course-concluding lectures aim to illustrate the integration of systems in the regulation of acid/base balance. Clinical examples of dysfunction will underscore the role of normal function, and some diseases will be traced to the deepest roots of their molecular etiology. Weekly take-home problem sets count 50 percent of the final grade.

**[BIOAP 4750 Mechanisms Underlying Mammalian Developmental Defects (also BIOMS/NS 4750)]**

Spring. 3 credits. Prerequisites: BIOMG 3300, 3310/3320, or 3330 (may be taken concurrently). S-U or letter grades. Offered alternate years; next offered 2011–2012.

D. Noden and P. Stover.

Focuses on the causes of developmental defects and how genetic changes or teratogenic insults disrupt developmental regulatory and metabolic pathways.]

**[BIOAP 4890 Mammalian Embryology (also BIOMG/BIOMS 4890)]**

Spring. 3 credits. Prerequisite: introductory biology. S-U or letter grades. Evening prelims. Offered alternate years; next offered 2011–2012. D. M. Noden.

Examines the early formation of the mammalian body and placenta, emphasizing comparative aspects, and morphogenesis and histogenesis of each organ system.]

**BIOAP 4980 Teaching Experience**

Fall or spring. 1–4 credits. Limited enrollment. Prerequisites: previous enrollment in course to be taught or equivalent. Note: Arts students may not count this course toward graduation but may, 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 or letter grades by 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.

**BIOAP 7140 Cardiac Electrophysiology**

Fall. 1 credit. S-U grades only. Offered alternate years. R. Gilmour.

Survey of cardiac potentials, passive membrane properties, ion channels, and cardiac arrhythmias. Emphasizes nonlinear dynamic aspects of cardiac electrophysiology and cardiac arrhythmias.

**BIOAP 7200 Animal Physiology and Anatomy Seminar**

Fall and spring. 1 credit each semester; may be repeated for credit. Prerequisite: admission to graduate field of physiology. S-U or letter grades. R. Davisson.

Designed to train graduate students in the field of physiology to become professional scientists. Students are required to give a seminar on their research. Advice and feedback are provided. Throughout the semester, advice is provided on subjects such as preparation of manuscripts, seminars, and grant proposals.

**[BIOAP 7570 Current Concepts in Reproductive Biology (also ANSC 7570)]**

Fall. 3 credits. Limited to 20 students. Prerequisites: undergraduate degree in biology and strong interest in reproductive biology. S-U or letter grades. Offered alternate years; next offered 2011–2012. J. E. Fortune, P. A. Johnson, and staff.

Team-taught survey course in reproductive physiology/endocrinology. Lectures on male reproductive function, female reproductive function, fertilization and gamete transport, pregnancy, parturition, lactation, aging, reproductive technology.]

**BIOAP 7940 Special Topics in Physiology**

Fall or spring. 1 or 2 credits per topic; may be repeated for credit. Enrollment in each topic may be limited. S-U or letter grades by permission of instructor. Staff.

Lectures, laboratories, discussions, and seminars on specialized topics.

**Related Courses in Other Departments**

Advanced Work in Animal Parasitology (VETMI 7370)

Animal Reproduction and Development (ANSC 2400)

Developmental Biology (BIOMG 3850)

Fundamentals of Endocrinology (ANSC 4270)

Research in Marine Biology (BIOSM 4130)

Sensory Function (BIONB 4920)

Teaching Experience (BIOG 4980)

Undergraduate Research in Biology (BIOG 4990)

## ECOLOGY AND EVOLUTIONARY BIOLOGY (BIOEE)

### BIOEE 1250 Biology Seminar

Fall or spring. 1–2 credits. Prerequisite: none. S–U grades only. Staff.

A first-year seminar designed for students with a strong interest in research. Students will interact with faculty while learning to read and evaluate scientific publications on current biological topics. Multiple topics and sections will be offered each semester.

### BIOEE 1540 Introductory Oceanography (also EAS 1540)

Fall or summer. 3 credits. S–U or letter grades. B. C. Monger and C. H. Greene.

For description, see EAS 1540.

### BIOEE 1560 Introductory Oceanography with Laboratory (also EAS 1560)

Fall, spring, or summer. 3 or 4 credits. B. C. Monger and C. H. Greene.

For description, see EAS 1560.

### BIOEE 1610 Ecology and the Environment (also BIOG 1610)

Fall, spring, or summer. 3 or 4 credits; 4-credit option involves writing component and two disc sec per week. S–U or letter grades; biological sciences majors must take course for a letter grade. A. S. Flecker and C. L. Goodale.

This course provides an introduction to ecology, covering interactions between organisms and the environment at scales of populations, communities, and ecosystems. Ecological principles are used to explore the theory and applications of major issues facing humanity in the 21st century, including population dynamics, disease ecology, biodiversity and invasive species, global change, and other topics of environmental sustainability.

### BIOEE 1780 Evolutionary Biology and Diversity (also BIOG 1780)

Fall or spring. 4 or 5 credits; 4 credits with 3 lec and 1 disc sec per week; 5 credits with 3 lec per week and a Writing in the Majors disc sec that meets twice per week. 5-credit option limited to 15 students per sec each semester. Students taking 5-credit option read additional materials from primary literature and write essays in place of regular exams. (Students may not preregister for 5-credit option; interested students complete application form on first day of class.) Limited to 300 students. S–U or letter grades; biological sciences majors must take course for a letter grade. One field trip. Evening prelims: spring, Mar. 3 and Apr. 5. Fall, K. R. Zamudio; spring, staff.

Considers explanations for pattern of diversity and the apparent good fit of organisms to the environment. Topics include the diversity of life, the genetics and developmental basis of evolutionary change, processes at the population level, evolution by natural selection, modes of speciation, long-term trends in evolution, origin of humans.

### BIOEE 2070 Evolution (also HIST 2870, STS 2871)

Fall or summer (six-week session). 3 credits. Intended for students with no background in college biology. May not be taken for credit after BIOEE/BIOG 1780. Does not meet evolutionary biology requirement for biological sciences major. S–U or letter grades. 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 2630 Field Ecology

Fall. 3 credits. Pre- or corequisite: BIOEE/BIOG 1610. Letter grades only. One weekend field trip. A. Agrawal.

Field exercises designed to give students direct experience with fieldwork, 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 2640 Tropical Field Ornithology

Winter, two-week, full-time course. 3 credits. Limited to 14 students; minimum of 7. Prerequisite: permission of instructor. Intended for students with limited or no bird knowledge. S–U or letter grades. Daily fieldwork, disc, reading, and individual project. A. A. Dhondt.

Provides students with the opportunity to study birds intensively in a neotropical environment. Students learn observational and field techniques, participate in group research projects and in daily seminars. The group is housed in the Biodiversity Center at Punta Cana. One or two field trips are taken to national parks in the Dominican Republic.

### BIOEE 2650 Tropical Field Ecology and Behavior

Winter, field course based in Kenya, Africa. 4 credits. Limited to 15 students. Prerequisite: permission of instructor. Letter grades only. I. J. Lovette.

Gives students a broad hands-on understanding of tropical biology, ecology, and behavioral ecology. Students gain experience with experimental design and data collection, field methods, basic statistics, interpretation and evaluation of primary scientific literature, and scientific paper writing. Students pay separately for their international airfare and there may also be a small supplementary laboratory fee.

### BIOEE 2670 Introduction to Conservation Biology (also NTRES 2670)

Fall. 2 or 3 credits, 3 credits with disc sec, two Sat a.m. field trips, and two essays. Intended for both science and nonscience majors. May not be taken for credit after NTRES 4100. Completion of BIOEE 2670 not required for NTRES 4100. S–U or letter grades. J. W. Fitzpatrick.

Broad exploration of biological concepts and practices related to conserving the earth's biodiversity; integrates ecological, evolutionary, behavioral, and genetic

principles important for understanding conservation issues of the 21st century. Topics include species and ecosystem diversity, values of biodiversity, causes of extinction, risks facing small populations, simulation modeling, design of nature preserves, the Endangered Species Act, conservation priority-setting, species recovery, ecosystem restoration and management, implications of climate change, and our ecological footprint.

### BIOEE 2740 The Vertebrates: Structure, Function, and Evolution

Spring. 4 credits. Prerequisite: two majors-level biology courses. S–U or letter grades. Fee: \$25. B. A. McGuire.

Introductory course in vertebrate organismal biology that 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, organ systems, thermoregulation, life history, locomotion, and behavior. Laboratories include dissections of preserved vertebrate animals and noninvasive live animal demonstrations.

### [BIOEE 3500 Dynamics of Marine Ecosystems (also EAS 3500)]

Fall. 3 credits. Limited to 25 students.

Prerequisites: one year calculus and semester oceanography (i.e., BIOEE/EAS 1540), or permission of instructor. S–U or letter grades. Offered alternate years; next offered 2011–2012. C. H. Greene and R. W. Howarth.

For description, see EAS 3500.]

### BIOEE 3510 Conservation Oceanography (also EAS 3510)

Spring, full-time, three-week course. 4 credits. Limited to 25 students. Prerequisites: enrollment in Cornell Abroad Earth and Environmental Sciences Semester in Hawaii; one semester calculus and two majors-level biology courses or permission of instructor. Letter grades only. C. H. Greene, C. D. Harvell, and B. C. Monger.

For description, see EAS 3510.

### BIOEE 3620 Dynamic Models in Biology (also MATH 3620)

Spring. 4 credits. Prerequisites: two majors-level biology courses and completion of mathematics requirements for Biological Sciences major or equivalent. S–U or letter grades. Offered alternate years. S. P. Ellner and 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 3630 Field Methods in Ornithological Research]

Summer (eight-week session). 5 credits. Limited to 15 students. Prerequisites: two majors-level biology courses, interest and ability to spend all day in the field under variable weather conditions, including intense sun and periods of rain, and permission of instructor. S–U or letter grades. Next offered 2013–2014. D. W. Winkler and staff.]

**BIOEE 3690 Chemical Ecology (also BIONB/ENTOM 3690)**

Spring. 3 credits. Prerequisites: one majors-level biology course and one semester introductory chemistry for majors or nonmajors or equivalents, or permission of instructor. S–U or letter grades. J. S. Thaler, A. Kessler, A. Agrawal, and R. Raguso.

Why are chilies so spicy? This course examines the chemical basis of interactions between species and is intended for students with a basic knowledge of chemistry and biology. Focuses on the ecology and chemistry of plants, animals, and microbes. Stresses chemical signals used in diverse ecosystems, using Darwinian natural selection as a framework. Topics include plant defenses, microbial warfare, communication in marine organisms, and human pheromones.

**[BIOEE 3730 Biodiversity and Biology of the Marine Invertebrates**

Fall (but course must be taken previous summer at Shoals Marine Laboratory [SML]), three-week, full-time course. 5 credits (students enroll for credit during fall semester). Limited to 24 students. Prerequisites: two majors-level biology courses; permission of faculty because off campus. Letter grades only. Daily and evening lec, lab, and fieldwork. Total cost for room, board, and overhead at SML: \$2,426. Offered alternate years; next offered 2011–2012. C. D. Harvell.]

**[BIOEE 4460 Plant Behavior—Induced Plant Responses to Biotic Stresses, Lectures (also BIONB 4460)**

Spring. 3 credits. Prerequisite: BIOEE/BIOG 1610 or permission of instructor. S–U or letter grades. Next offered 2011–2012. A. Kessler and R. Raguso.]

**[BIOEE 4461 Plant Behavior—Induced Plant Responses to Biotic Stresses, Laboratory (also BIONB 4461)**

Spring. 1 credit. Limited to 12 students. Pre- or corequisite: BIOEE 4460 or BIONB 4460. S–U or letter grades. Next offered 2011–2012. A. Kessler and R. Raguso. Laboratory course covering topics presented in BIOEE 4460/BIONB 4460.]

**[BIOEE 4500 Mammalogy, Lectures**

Spring. 3 credits. Recommended: BIOEE 2740. Letter grades; S–U grades by permission of instructor. Offered alternate years; next offered 2011–2012. B. A. McGuire.]

**[BIOEE 4501 Mammalogy, Laboratory**

Spring. 1 credit. Limited to 16 students. Pre- or corequisite: BIOEE 4500. Letter grades; S–U grades by permission of instructor. Fee: \$20. Travel to Cornell University Museum of Vertebrates (CUMV) at the Laboratory of Ornithology is necessary. One all-day field trip may be scheduled. Offered alternate years; next offered 2011–2012. B. A. McGuire.]

**BIOEE 4530 Speciation**

Spring. 4 credits. Limited to 40 students. Prerequisites: BIOEE/BIOG 1780 and BIOMG 2810 or equivalents, or permission of instructor. S–U or letter grades. Offered alternate years. R. G. Harrison. Advanced course in evolutionary biology focusing on the pattern and process of speciation and the nature and origin of intrinsic barriers to gene exchange. Lecture topics 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, and rates of speciation. Emphasis is on developing a rigorous conceptual framework for discussing speciation and on detailed analysis of a series of case histories.

**BIOEE 4550 Insect Ecology (also ENTOM 4550)**

Fall. 4 credits. Recommended: ENTOM 2120 or BIOEE/BIOG 1610 or permission of instructor. S–U or letter grades. Offered alternate years. J. S. Thaler. For description, see ENTOM 4550.

**[BIOEE 4560 Stream Ecology (also NTRES 4560)**

Fall. 4 credits. S–U or letter grades. Field project with lab papers. One Sat. field trip. Offered alternate years; next offered 2011–2012. A. S. Flecker and C. E. Kraft. For description, see NTRES 4560.]

**[BIOEE 4570 Limnology: Ecology of Lakes, Lectures**

Spring. 3 credits. Prerequisite: BIOEE/BIOG 1610 or written permission of instructor. Recommended: introductory chemistry. Letter grades; S–U grades by permission of instructor only. Offered alternate years; next offered 2011–2012. N. G. Hairston, Jr.]

**[BIOEE 4571 Limnology: Ecology of Lakes, Laboratory**

Spring. 2 credits. Pre- or corequisite: BIOEE 4570. Letter grades; S–U grades by permission of instructor only. One weekend field trip. Fee for food on field trip: \$15. Offered alternate years; next offered 2011–2012. N. G. Hairston, Jr. and staff.]

**[BIOEE 4580 Community Ecology**

Spring. 4 credits. Prerequisites: BIOEE/BIOG 1610, 1780, or permission of instructor. S–U or letter grades. Offered alternate years; next offered 2011–2012. M. A. Geber and A. Agrawal.]

**[BIOEE 4600 Theoretical Ecology**

Spring. 4 credits. Limited enrollment. Prerequisites: completion of Biological Sciences mathematics requirement or equivalent, and either one additional semester mathematics, statistics, or modeling (e.g., BEE 2600/4530/4750, NTRES 3100/4110, BIONB 4220) or permission of instructor. S–U or letter grades. Offered alternate years; next offered 2011–2012. S. P. Ellner.]

**BIOEE 4620 Marine Ecology (also EAS 4620)**

Fall. 3 credits. Limited to 75 students. Prerequisite: BIOEE/BIOG 1610. Letter grades; S–U grades by permission of instructor only. 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 4640 Macroevolution**

Spring. 4 credits. Limited to 35 students. Prerequisite: BIOEE/BIOG 1780 or permission of instructor. Intended for juniors, seniors, and beginning graduate students; freshmen and sophomores with permission of instructor. Interested graduate students strongly encouraged to preregister. Letter grades; S–U grades by permission of instructor only. Offered alternate years; next offered 2011–2012. A. R. McCune.]

**BIOEE 4660 Physiological Plant Ecology, Lectures**

Spring. 3 credits. Limited to 30 students. Prerequisite: BIOEE/BIOG 1610 or introductory plant physiology. Letter grades; S–U grades by permission of instructor only. Offered alternate years. J. P. Sparks.

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 4661 Physiological Plant Ecology, Laboratory**

Spring. 2 credits. Limited to 15 students. Pre- or corequisite: BIOEE 4660. Letter grades only. Offered alternate years. J. P. Sparks.

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 per week in additional lab time for this course.

**BIOEE 4670 Seminar in the History of Biology (also HIST 4150, BSOC/STS 4471, LAW 7652)**

Fall or summer (six-week session). 4 credits. Limited to 18 students. S–U or letter grades. W. B. Provine.

Specific topics change each year.

**[BIOEE 4690 Food, Agriculture, and Society (also BSOC/STS 4691)**

Spring. 3 credits. Limited to 20 students. Prerequisite: introductory ecology course or permission of instructor. S–U or letter grades. Next offered 2011–2012. A. G. Power.]

**BIOEE 4700 Herpetology, Lectures**

Spring. 2 credits. Limited to 50 students. Recommended: BIOEE 2740 and concurrent enrollment in BIOEE 4701.

Letter grades; S–U grades by permission of instructor only. Offered alternate years. H. W. Greene.

Lectures cover various aspects of the biology of amphibians and reptiles, including evolution, zoogeography, ecology, behavior, and physiology.

**[BIOEE 4701 Herpetology, Laboratory**

Spring. 2 credits. Limited to 35 students. Pre- or corequisite: BIOEE 4700. Letter grades; S-U grades by permission of instructor only. Fee: \$30. Occasional field trips and special projects. Offered alternate years; next offered 2012-2013. H. W. Greene.]

**[BIOEE 4730 Ecology of Agricultural Systems (also HORT 4730)**

Fall. 3 credits. Limited to 45 students. Prerequisite: BIOEE/BIOG 1610 or permission of instructor. S-U or letter grades. During first six weeks of class, Thurs. meetings may run later because of field trips. L. E. Drinkwater.

Analysis of the ecological processes operating in agricultural systems, with an emphasis on understanding relationships between agroecosystem structure and function and interactions among organisms. Examines agroecological theory and research through readings and discussions. The first part of this course emphasizes understanding biogeochemical processes, population and community ecology with emphasis on plant-herbivore and plant-microbial interactions, and evolutionary processes in agroecosystems. The latter part focuses on the application of ecological knowledge to the design and management of multifunctional agroecosystems. Field trips to local farms and case studies from both the tropics and the temperate zone are used to illustrate important concepts.

**[BIOEE 4750 Ornithology**

Spring. 4 credits. Limited to 35 students. Prerequisite: permission of instructor by preregistering in E141 Corson Hall. Recommended: BIOEE 2740. Letter grades; S-U grades by permission of instructor only. Carpooling to Lab of Ornithology necessary. Fee: \$15. Occasional field trips and special projects. Offered alternate years; next offered 2011-2012. D. W. Winkler.]

**[BIOEE 4760 Biology of Fishes**

Fall. 4 credits. Limited to 24 students. Recommended: BIOEE 2740 or equivalent experience in vertebrate zoology. Letter grades; S-U grades by permission of instructor only. Small lab fee may be required. Two field trips. Offered alternate years. A. R. McCune.

Introduction to the study of fishes: their structure, physiology and functional morphology, behavior, ecology, diversity, evolution, classification, and identification. Emphasizes marine fishes from different habitats (temperate, tropical coral reef, intertidal, and deep sea); local freshwater species; and interesting freshwater fishes from around the world, especially South America and Africa. 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 4770 Marine Invertebrates Seminar**

Fall. 1 credit. Prerequisite: BIOEE 3730 or permission of instructor. S-U grades only. Offered alternate years; next offered 2011-2012. C. D. Harvell.]

**[BIOEE 4780 Ecosystem Biology**

Spring. 4 credits. Prerequisite: BIOEE/BIOG 1610 or equivalent. S-U or letter grades. Offered alternate years. C. L. Goodale and R. W. Howarth.

Analyzes ecosystems in terms of energy flow and nutrient cycles, emphasizing an experimental approach and comparative aspects of terrestrial, freshwater, and marine ecosystems. Considers anthropogenic effects on ecosystems, such as from acid precipitation, fossil fuel combustion, and nitrogen pollution. Also analyzes climate change and regional environmental change from an ecosystem perspective.

**[BIOEE 4790 Paleobiology (also EAS 4790)**

Spring. 4 credits. Prerequisites: two majors-level biology courses and either BIOEE 2740, 3730, EAS 3010, or permission of instructor. S-U or letter grades. W. D. Allmon.

For description, see EAS 4790.

**[BIOEE 4800 Ecological Genetics (also ENTOM 4700)**

Spring. 4 credits. Prerequisite: BIOEE/BIOG 1780. Recommended: introductory course in genetics and/or statistics. S-U or letter grades. Offered alternate years. B. P. Lazzaro.

For description, see ENTOM 4700.

**[BIOEE 4900 Topics in Marine Biology**

Spring. 2 credits; may be repeated for credit. Limited to 15 students. Prerequisite: permission of instructor. Primarily for undergraduates. S-U or letter grades. Offered alternate years. J. G. Morin.

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 4940 Special Topics in Ecology and Evolutionary Biology**

Fall or spring. 1-4 credits. S-U or letter grades. Staff.

The department offers "trial" courses or seminars under this number. Offerings vary by semester and are advertised by the department before the semester starts. Courses offered under this number will be approved by the Biological Sciences Curriculum Committee, and the same course is not to be offered more than twice under this number.

**[BIOEE 4980 Teaching Experience**

Fall or spring. 1-4 credits. Limited enrollment. Prerequisites: previous enrollment in course to be taught or equivalent. Note: Arts students may not count this course toward graduation but may, 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 or letter grades by 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.

**[BIOEE 6600 Field Studies in Ecology and Evolutionary Biology**

Fall or spring. Variable credit. Prerequisites: BIOEE/BIOG 1610, taxon-oriented course, and permission of instructor. Letter grades; S-U grades by permission of instructor only. Lec and field trips TBA. Estimated costs: TBA. Staff.

Provides students with opportunities to learn field techniques and new biota 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.

**[BIOEE 6601 Tropical Field Ecology**

Spring. 2 credits. Prerequisite: for undergraduates, experience or course work with terrestrial, marine, or freshwater organisms. Extended field trip over winter break. Letter grades only. Fee to cover transportation and housing: TBA. Offered alternate years. C. D. Harvell, J. P. Sparks, and N. G. Hairston, Jr.

Field trip to the big island of Hawaii, the Yucatan Coast of Mexico, or similar environment; check with instructors for planned location. Students employ experimental approaches to study ecological and evolutionary questions across a range of tropical biomes. Optional vertebrate dissection (fish) during a portion of the course field trip.

**[BIOEE 6602 Graduate Field Course in Ecology**

Spring. 3 credits. Prerequisite: graduate standing. Letter grades only. Fee charged to help cover food and lodging for trip to Florida. Offered alternate years; next offered 2011-2012. J. P. Sparks and H. W. Greene.]

**[BIOEE 6610-6611 Environmental Policy (also ALS/BSOC 6610-6611)**

6610, fall; 6611, spring. 3 credits each semester; students must register for 6 credits each semester since R grade given at end of fall semester. Limited to 12 students. Prerequisite: permission of instructor. Letter grades only. D. Pimentel.

Focuses on complex environmental issues. Ten to 12 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 6680 Principles of Biogeochemistry**

Spring. 4 credits. Limited to 20 students. Prerequisite: solid background in ecology, environmental chemistry, or related environmental science; for undergraduates, permission of instructor. S-U or letter grades. Offered alternate years; next offered 2011-2012. R. W. Howarth and C. L. Goodale.]

**[BIOEE 6750 Current Topics in Plant Molecular Ecology**

Fall. 1 credit; may be repeated for credit. Limited to 20 students. Prerequisite: graduate standing or permission of instructor. S-U or letter grades. Next offered 2011-2012. A. Kessler.]

**BIOEE 6900 Seminar in Ecology and Evolution of Infection and Disease (also ENTOM 6900)**

Fall or spring. 1 credit; may be repeated for credit. S-U grades only. B. Lazzaro, A. Hajek, C. D. Harvell, and staff. For description, see ENTOM 6900.

**BIOEE 7600 Special Topics in Evolution and Ecology**

Fall or spring. 1–3 credits; may be repeated for credit. Limited enrollment. Letter grades; S–U grades by permission of instructor only. Staff. Independent or group-intensive study of special topics of current interest. Content varies each semester.

**BIOEE 7610 Microsatellite DNA: Techniques**

Fall. 1 credit; may be repeated for credit. Limited to 12 students. Prerequisite: permission of instructor. Primarily for graduate students; undergraduates admitted only under exceptional circumstances. E-mail S. M. Bogdanowicz (smb31) by early Aug. if interested. S–U grades only. Fee: TBA. R. G. Harrison and S. M. Bogdanowicz. Construct and screen genomic DNA libraries for microsatellite loci using next-generation sequencing technologies. Lectures and group discussions regarding microsatellite isolation, characterization, and evolution. Informal presentations of student research projects.

**BIOEE 7640 Plant-Insect Interactions Seminar**

Fall or spring. 1 credit; may be repeated for credit. Prerequisite: for undergraduates, permission of instructor. S–U grades only. A. Agrawal, J. S. Thaler, and A. Kessler. Group intensive study of current research in plant-insect interactions. Topics vary from semester to semester but include chemical defense, coevolution, insect community structure, population regulation, biocontrol, tritrophic interactions, and mutualism.

**BIOEE 7670 Current Topics in Ecology and Evolutionary Biology**

Fall. 3 credits. Prerequisite: for undergraduates, permission of instructor. S–U grades only. M. A. Geber. 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 7700 Workshop in Biogeochemistry**

Fall or spring. 1–3 credits; may be repeated for credit. Limited to 15 students. Prerequisite: BIOEE 6680. S–U grades only. Staff. Workshop-forum in which graduate students interact with invited world leaders in biogeochemistry. Workshop topics change each semester. A one-week workshop is preceded by seven one-hour preparatory discussions of readings.

**BIOEE 7800 Graduate Seminar in Ornithology (also NTRES 7800)**

Fall or spring. 1 credit; may be repeated for credit. Prerequisite: for undergraduates, permission of instructor. S–U grades only. I. J. Lovette, A. A. Dhondt, D. W. Winkler. Group intensive study of current research in ornithology. Topics vary from semester to semester.

**BIOEE 8990 M.S. Thesis Research**

Fall or spring. 1–15 credits. Prerequisite: admission to field of ecology and evolutionary biology. S–U grades only. 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 9990 Ph.D. Dissertation Research**

Fall or spring. 1–15 credits. Prerequisite: admission to field of ecology and evolutionary biology as Ph.D. student. S–U grades only. 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**

Ethics and the Environment (BSOC/STS 2061, PHIL 2460)  
Physical Hydrology for Ecosystems (BEE 3710)  
Evolution of the Earth and Life (EAS 1700)  
General Microbiology, Lectures (BIOMI 2900)  
Prokaryotic Diversity (BIOMI 4140)  
Neurobiology and Behavior I: Introduction to Behavior (BIONB 2210)  
Methods in Animal Behavior (BIONB 3230)  
Insect Behavior (BIONB/ENTOM 3250)  
Ecology of Animal Behavior (BIONB/BIOSM 3290)  
Modeling Behavioral Evolution (BIONB 4220)  
Animal Communication (BIONB 4260)  
Darwinian Medicine (BIONB 4270)  
Introductory Botany (BIOPL 2410)  
Vascular Plants Systematics (BIOPL 2480)  
Phylogenetic Systematics (BIOPL/ENTOM 4400)  
Molecular Systematics (BIOPL 4470)  
Plant Evolution and the Fossil Record (BIOPL 4480)  
Field Ornithology (BIOSM 3740)  
Field Marine Biology and Ecology (FMBE) (BIOSM 3750)  
Marine Botany (BIOSM 4490)  
Biological Statistics I (BTRY 3010, NTRES 3130, STSCI 2200)  
Statistical Genomics (BTRY 4820)  
Statistical Methods III: Categorical Data (BTRY 6030, ILRST/STSCI 4110)  
Soil Science (CSS 2600)  
Geographic Information Systems (CSS 4200)  
Practicum in Forest Farming as an Agroforestry System (CSS/HORT/NTRES 4260)  
Soil Ecology (CSS/HORT 4660)

Introductory Geological Sciences (To Know Earth) (EAS 1101)  
Evolution of the Earth System (EAS 3010)  
Introduction to Biogeochemistry (EAS/NTRES 3030)  
Insect Biology (ENTOM 2120)  
Insect Phylogeny and Evolution (ENTOM 3310)  
Maggots, Grubs, and Cutworms: Larval Insect Biology (ENTOM 3330)  
Multivariate Analysis (ILRST/BTRY 4100)  
Human Biology and Evolution (NS/ANTHR 2750)  
Environmental Conservation (NTRES 2010)  
Applied Population Ecology (NTRES 3100)  
Global Ecology and Management (NTRES 3220)  
Forest Ecology (NTRES 4200)  
Forest Ecology, Laboratory (NTRES 4201)  
Wetland Ecology, Lec/Lab (NTRES 4220/4221)  
Fungi (PLPA 3090)

**MOLECULAR BIOLOGY AND GENETICS (BIOMG)****BIOMG 1250 Biology Seminar**

Fall and spring. 1–2 credits. Prerequisite: none. S–U grades only. Staff. A first-year seminar designed for students with a strong interest in research. Students will interact with faculty while learning to read and evaluate scientific publications on current biological topics. Multiple topics and sections will be offered each semester.

**BIOMG 1320 Orientation Lectures in Molecular Biology and Genetics**

Spring, weeks 1–3. 0 credits. Primarily for freshmen, sophomores, and transfer students. S–U grades only. J. Blankenship. Six professors discuss their research and promising new areas for research in the future.

**BIOMG 1350 Principles of Cell and Developmental Biology (also BIOG 1350)**

Fall, spring, summer. 3 credits. Prerequisite: none. S–U or letter grades; biological sciences majors must take course for a letter grade. Lec, disc. A. Bretscher, M. Garcia-Garcia, T. Huffaker, and K. Kempthues. The course introduces molecular mechanisms by which cells behave, divide, and grow as individuals; how they organize during embryonic development to form functional tissues and organs in multicellular organisms; and how their misbehavior contributes to disease.

**BIOMG 2800 Lectures in Genetics and Genomics**

Fall, spring, or summer (eight-week session). 3 credits. Lec component of BIOMG 2810. Not open to students majoring in biological sciences; may not be used to fulfill requirements for biological sciences major. Not open to freshmen fall semester. Highly recommended: problem-solving sessions. T. D. Fox, M. L. Goldberg, and D. Nero.

For description, see BIOMG 2810.

**BIOMG 2810 Genetics and Genomics (also BIOG 2810)**

Fall, spring, or summer (eight-week session). 5 credits. Not open to freshmen fall semester. Prerequisite: BIOG 1500 recommended. Lec, lab. In fall and spring labs are held T, W, R, F, 2:30-4:30. Lab sign-ups done in first lec. Highly recommended: problem-solving sessions. S-U or letter grades. Biological sciences majors must take course for a letter grade. Evening prelims. T. D. Fox, M. L. Goldberg, and D. Nero.

General introduction to the fundamental principles of genetics in eukaryotes and prokaryotes. Topics include gene transmission, linkage, recombination, structure, mutations, and manipulation, as well as analysis of genomes in individuals and populations.

**BIOMG 3300-3350 Principles of Biochemistry**

Introductory biochemistry is offered in four formats: individualized instruction (one-semester course, fall and spring, BIOMG 3300); lecture (one-semester course, spring only, BIOMG 3350); lecture (two-semester sequence, BIOMG 3310 [fall] and BIOMG 3320 [spring]); and lecture (BIOMG 3330 [summer]). The Biochemistry and Molecular and Cell Biology programs of study require 5 credits of biochemistry (either BIOMG 3310 and 3320, or BIOMG 3300 and 3340).

**BIOMG 3300 Principles of Biochemistry, Individualized Instruction (also BIOG 3300)**

Fall or spring. 4 credits. Prerequisites: one majors-level biology course and one year general chemistry and CHEM 1570 or 3570-3580 (CHEM 3580 may be taken concurrently) or equivalent, or permission of instructor. Recommended: concurrent registration in BIOMG 3340. May not be taken for credit after BIOMG 3310, 3320, 3330, or 3350. S-U or letter grades; biological sciences majors must take course for a letter grade. Evening prelims: fall, Sept. 30 and Nov. 2; spring, Feb. 24 and April 5. J. E. Blankenship, P. C. Hinkle, Y. Mao, 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.

**BIOMG 3310 Principles of Biochemistry: Proteins and Metabolism**

Fall. 3 credits. Prerequisites: one majors-level biology course and one year general chemistry, and CHEM 1570 or 3570-3580 (CHEM 1570 or 3570 should not be taken concurrently) or equivalent, or permission of instructor. May not be taken for credit after BIOMG 3300, 3330, or 3350. S-U grades by permission of instructor. Lec; evening prelim Oct. 21. G. W. Feigenson. (An optional discussion section is held on most Fridays from 2:30 to 3:20 p.m.

focusing on issues such as application to medical school or graduate school, and undergraduate research).

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.

**BIOMG 3320 Principles of Biochemistry: Molecular Biology**

Spring. 2 credits. Prerequisites: one majors-level biology course and previous or concurrent registration in organic chemistry, or permission of instructor. May not be taken for credit after BIOMG 3300 or 3330 or 3350. S-U or letter grades by permission of instructor. Lec. M. B. Smolka and A. W. Grimson.

Comprehensive course in molecular biology that covers the structure and properties of DNA, DNA replication and repair, synthesis and processing of RNA and proteins, the regulation of gene expression, and the principles and applications of recombinant DNA technologies, genomics, and proteomics.

**BIOMG 3330 Principles of Biochemistry: Proteins, Metabolism, and Molecular Biology (also BIOG 3330)**

Summer, six-week session. 4 credits. Prerequisites: one majors-level biology course and one year general chemistry, and CHEM 1570, or 3570-3580, or equivalents, or permission of instructor. S-U or letter grades; biological sciences majors must take course for a letter grade. May not be taken for credit after BIOMG 3300, 3310, 3320, or 3350. S. Ely and H. Nivison.

Comprehensive introduction to biologically important molecules and polymers. Topics include protein structure and function, enzyme catalysis, metabolic regulatory pathways, DNA and RNA structure, DNA replication and repair, gene expression, protein synthesis, and modern DNA technologies. This is a summer session taught in a lecture format.

**BIOMG 3340 Computer Graphics and Molecular Seminars**

Fall or spring. 1 credit. Prerequisite: BIOMG 3330, 3350, 3310/3320 (BIOMG 3320 may be taken concurrently), or Corequisite: BIOMG 3300. J. E. Blankenship, P. C. Hinkle, Y. Mao, and staff.

Visualization of complex biomolecules using computer graphics techniques. Group presentations on current topics in molecular biology.

**BIOMG 3350 Principles of Biochemistry: Proteins, Metabolism, and Molecular Biology (also BIOG 3350)**

Spring. 4 credits. Prerequisite: one majors-level biology course and one year general chemistry, and CHEM 1570, or 3570-3580, or equivalents, or permission of instructor. CHEM 3580 may be taken concurrently. May not be taken for credit after BIOMG 3300, 3310, 3320, or 3330. S-U or letter grades; biological sciences majors must take course for a letter grade. Lec and disc. B. Tye and C. Fromme.

Comprehensive introduction to biologically important molecules and polymers. Topics include protein structure and function, enzyme catalysis, metabolic regulatory pathways, DNA and RNA structure, DNA replication and repair,

modern DNA technologies, gene expression, and protein synthesis.

**BIOMG 3850 Developmental Biology**

Fall. 3 credits. Prerequisite: BIOMG 2810. Lec. K. Liu.

Introduction to the morphogenetic, molecular and cellular, and genetic aspects of the developmental biology of animals.

**BIOMG 4000 A Genomics Approach to Studying Life**

Fall. 3 credits. Prerequisites: two majors-level biology courses and BIOMG 2810 or 3300, or 3330, or 3350 or 3310/3320 or permission of instructor. S-U or letter grades. Lec. J. C. Schimenti.

Introduction to principles underlying the organization of genomes and the methods of studying them, emphasizing genome-wide approaches to research. Covers the application of genomics methodologies for addressing issues including gene regulation, evolution, complex systems, genetics, and gene: phenotype relationships. Landmark and timely genomics papers and other research developments will be discussed. Basic bioinformatics tools will be incorporated.

**BIOMG 4310 Frontiers in Biophysics**

Fall, full day of lec, S, Sept. 18, 9 a.m.-4 p.m., Racker Room, Biotechnology Bldg. 0.5 credit. S-U grades only. G. W. Feigenson and staff.

Overview of current research in biophysics at Cornell by faculty from different departments across the university. Designed for undergraduates considering a career in biophysics and for graduate students interested in biophysics research opportunities at Cornell.

**BIOMG 4320 Survey of Cell Biology**

Spring. 3 credits. Prerequisite: BIOMG 3300 or 3330 or 3350 or 3310 and previous or concurrent registration in 3320, or equivalent. Recommended: BIOMG 2810. Lec. Undergraduate students must enroll in this course for letter grade; graduate students may enroll either for letter grade or S-U. Evening prelims Mar. 8 and Apr. 21. V. M. Vogt.

Survey of a wide array of topics focusing on the general properties of eukaryotic cells. 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 BIOMG 4370, BIOMG 4830, BIOMG 6360, and 6390.

**BIOMG 4340 Applications of Molecular Biology to Medicine, Agriculture, and Industry**

Fall. 3 credits. Prerequisites: BIOMG 3300 or 3330 or 3350 or 3310/3320. Recommended: BIOMG 4320. Letter grades. Lec. S. Ely.

Lecture topics emphasize transgenic animal and plant systems that constitute marketed or near-market applications such as production of pharmaceuticals in milk, edible and nucleic acid vaccines, gene therapy, and high-tech agricultural products. Additional topics may include cancer treatments and relevant aspects of the human genome projects. An overview of human immunology and its relationship to drug development will be provided. Students will also explore relevant scientific literature.

**BIOMG 4350 Undergraduate Biochemistry Seminar**

Fall or spring, 1 credit; may be repeated. Prerequisites: upper-class standing; BIOMG 3300, or 3330, or 3350 or 3310/3320, or written permission of instructor. S-U grades only. D. Wilson.

Selected papers from the literature on a given topic are evaluated critically during 12 one-hour meetings.

**BIOMG 4370 Regulation of Cell Proliferation, Senescence, and Death (also TOX 4370)**

Fall. Variable credit; students may take lec for 2 credits or lec and disc for 3 credits. Limited to about 20 students per disc; priority given to graduate students. Prerequisite: two majors-level biology courses and BIOMG 3300, or 3330, or 3350, or 3310/3320. Recommended: BIOMG 2810 and BIOMG 4320. S-U or letter grades. S. Lee.

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. A discussion section covers primary literature in related areas.

**BIOMG 4380 The RNA World**

Spring, 3 credits. Prerequisites: BIOMG 3300, or 3330, or 3350, or 3310/3320 or permission of instructor. A. Ke.

Part of the excitement about "the RNA world" stems from the recognition that RNA is ancient and that the evolution of life as we know it depended upon RNA evolving both informational and catalytic capabilities. This course explores these ideas but more generally provides a comprehensive introduction to RNA biology. Many of the most interesting topics in the RNA biology, such as the mechanism of the RNA interference and its widespread applications, will be covered in detail. Other topics require consideration of essential RNA-protein complexes such as ribosomes, spliceosomes, telomerase, and Signal recognition particles. Classical experiments as well as up-to-date research are covered in this course. A portion of each class is devoted to discussion and questions.

**BIOMG 4400 Laboratory in Biochemistry and Molecular Biology**

Fall, spring, or summer (six-week session). 4 credits. Limited enrollment. Priority given to undergraduate biology majors in Biochemistry or Molecular and Cell Biology programs of study and to graduate students with minor in field of biochemistry. Prerequisites: BIOMG 3300, or 3330, or 3350, or 3310/3320 (at least one of 3310/3320 completed but one may be taken concurrently). S. Ely and H. Nivison.

Experiments related to molecular biology (includes PCR, DNA cloning, hybridization analysis, restriction mapping, and DNA sequence analysis), protein purification and analysis (salt fractionation, ion exchange chromatography, affinity chromatography, SDS-PAGE, and immunoblotting), and determination of enzyme kinetic parameters.

**BIOMG 4430 Experimental Molecular Neurobiology (also BIONB 4300)**

Spring, 4 credits. Limited to 12 students. Letter grades only. Disc, lab. Offered alternate years. D. L. Deitcher.

For description, see BIONB 4300.

**BIOMG 4450 Stem Cell Biology: Basic Science and Clinical Applications**

Spring, 3 credits. Limited to 40 students. Prerequisites: BIOMG 4320 or BIOMG 3850 or permission of instructor. S-U grades by permission of instructor. Lec, disc. T. Tumber.

This course will cover basic aspects of tissue morphogenesis and homeostasis with emphasis on the biological role of embryonic and adult stem cells in development, and their possible clinical applications. The focus will be placed on mouse and human stem cells. The discussion will be structured around relevant research papers that allow more in-depth analysis of the material taught during lectures.

**BIOMG 4500 Principles of Chemical Biology (also CHEM 4500)**

Fall, 3 credits. Prerequisites: CHEM 3570-3580 or 3590-3600 or equivalent. Staff.

For description, see CHEM 4500.

**BIOMG 4510 Structural Chemical Biology (also CHEM 4510)**

Spring, 3 credits. Prerequisites: CHEM 2880 and 3580 or equivalent. S. Ealick.

For description, see CHEM 4510.

**BIOMG 4610 Development and Evolution**

Spring, 3 credits. Prerequisites: BIOEE 1780, BIOMG 2810, BIOMG 3300, or 3330, or 3320, or 3350. Recommended: BIOMG 3850. Lec. Offered alternate years. M. F. Wolfner.

This course explores the molecular and genetic pathways and mechanisms that regulate animal development, and how they are modified through evolution to result in the dazzling array of forms and functions seen in the animal kingdom.

**BIOMG 4710 Insect Development (also ENTOM 4710)**

Fall, 3 credits. Prerequisites: BIOMG 1350 or ENTOM 2120 or permission of instructor. D. Knipple.

For description, see ENTOM 4710.

**BIOMG 4810 Population Genetics**

Fall, 4 credits. Prerequisite: BIOMG 2810, BIOEE 1780, or equivalents. Lec, disc. C. F. Aquadro.

Population genetics is the study of the transmission of genetic variation through time and space. This course 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, personalized medicine, the genetic structure and evolution of natural and domesticated populations, and the study of adaptation at the molecular level. Examples are drawn from studies of animals, plants, and microbes.

**BIOMG 4825 Molecular Biology of Plant Organelles (also BIOPL 4825)**

Spring, 1 credit. Prerequisites: BIOPL 4831 or BIOMG 2810 and permission of instructor. S-U or letter grades. Offered alternate years. M. R. Hanson and D. B. Stern.

For description, see BIOPL 4825.

**BIOMG 4831 Concepts and Techniques in Plant Molecular Biology (also BIOPL/PLPA/PLBR 4831)**

Fall, 3 credits. Prerequisites: BIOMG 2810 and BIOMG 3300, 3330, 3350, or 3320. Recommended: BIOMG 3310. Lec. Letter grades; S-U by permission of instructor. M. Scanlon, M. Hanson, and T. Owens.

For description, see BIOPL 4831.

**BIOMG 4834 Molecular Aspects of Plant Development Networks and Signaling (also BIOPL 4834)**

Fall, 1 credit, 12 lec. Offered alternate years. J. B. Nasrallah.

For description, see BIOPL 4834.

**BIOMG 4840 Molecular Evolution**

Spring, 3 credits. Prerequisite: BIOMG 2810. Lec. D. A. Barbash.

Explores the various processes by which DNA and protein sequences evolve over time, and how this evolution at the molecular level relates to changes in the morphology, behavior, and physiology of organisms that have occurred over time scales ranging from thousands to billions of years. After developing basic principles the course discusses the evolution and organization of genomes from microbes to higher eukaryotes, including humans, and the relationship between molecular evolution at the sequence level and the evolution of developmental pathways and systems.

**BIOMG 4850 Bacterial Genetics (also BIOMI 4850)**

Fall, 2 or 3 credits; optional 1 credit for registered students with permission of instructor to review literature. Prerequisite: BIOMG 2810. Recommended: BIOMI 2900 and BIOMG 3300, or 3330, or 3350 or 3310/3320. J. E. Peters.

For description, see BIOMI 4850.

**BIOMG 4860 Eukaryotic Genetics**

Spring, 4 credits. Enrollment may be limited to 50 students. Prerequisites: BIOMG 2810, BIOMG 3300 or 3330 or 3350 or 3310 and 3320. S-U or letter grades. E. Alani.

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.

**BIOMG 4870 Human Genomics**

Fall, 3 credits. Prerequisite: BIOMG 2810. Lec. A. G. Clark.

Applies fundamental concepts of transmission, population, and molecular genetics to the problem of determining the degree to which familial clustering of diseases in humans has a genetic basis. Emphasizes the role of full genome knowledge in expediting this process of gene discovery. Stresses the role of statistical inference in interpreting genomic

information. Population genetics, and the central role of understanding variation in the human genome in mediating variation in disease risk, are explored in depth. Methods such as homozygosity mapping, linkage disequilibrium mapping, and admixture mapping are examined. The format is a series of lectures with classroom discussion. Assignments include a series of problem sets and a term paper.

**[BIOMG 4890 Mammalian Embryology (also BIOAP/BIOMS 4890)]**

Spring. 3 credits. Prerequisite: introductory biology. Offered alternate years. D. M. Noden.

Examines the early formation of the mammalian body and placenta, emphasizing comparative aspects, and morphogenesis and histogenesis of each organ system.]

**BIOMG 4900 Manipulating the Mouse Genome (also NS 4900)**

Fall. 1 credit. Course meets during first half of semester and provides background information for VTBS 7010/TOX 7010 Mouse Pathology and Transgenesis, which meets during second half. Students interested in both courses must register for them separately. Prerequisites: BIOMG 2810 and 3300, or 3320, or 3330, or 3350, or NS 3200. Letter grades only. P. D. Soloway.

Functional genomic analysis has benefited enormously from experimental manipulation of the genomes of many organisms. The mouse has been the model of choice for such studies in mammals. This course explores the tools available for experimental manipulation of the mouse genome, including transgenesis, gene targeting, gene trapping, chemical mutagenesis, and cloning by nuclear transplant. Also discussed are use of recombinant inbred mice for complex trait analysis. Readings from the scientific literature focus on seminal applications of these methods.

**BIOMG 4980 Teaching Experience**

Fall or spring. 1-4 credits. Limited enrollment. Prerequisites: previous enrollment in course to be taught or equivalent. Note: Arts students may not count this course toward graduation but may, 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 or letter grades by 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.

**BIOMG 6080 Epigenetics (also NS 6080)**

Fall. 2 credits. Prerequisites: BIOMG 2810 and 3300, or 3320, or 3330, or 3350 or NS 3200. Letter grades only. Planned W F 11:15-12:05; occasional evening meetings for student presentations. P. D. Soloway. Epigenetic effects refer to reversible alterations in chromatin structure that can stably and heritably influence gene expression. These changes include covalent modifications to DNA itself or to proteins bound to DNA as well as noncovalent remodeling of chromatin. This course examines selected epigenetic phenomena described in several eukaryotes,

mechanisms regulating these effects, and their phenotypic consequences when normal regulation is lost. Reading materials are from current literature, and participation in class discussion is required.

**[BIOMG 6100 Genomes as Chromosomes**

Fall. 3 credits. Limited to 15 students. Prerequisites: BIOMG 2810 and 3300 or 3330 or 3350 or 3310/3320 or equivalent by permission of instructor. Letter grades only. Offered alternate years; next offered 2011-2012. P. E. Cohen.]

**BIOMG 6120 Overview of Model Genetic Organisms**

Spring, 2nd 6 weeks of semester. 1 credit. Limited to 20 students. Prerequisites: BIOMG 2810 or 4000 or permission of instructor. S-U or letter grades. Offered alternate years. J. Schimenti and staff.

Presents the features of various model organisms and their relative merits for conducting various types of genomics/genetics research. Model systems discussed include yeast, *Arabidopsis*, *Drosophila*, *C. elegans*, zebrafish, and mice.

**BIOMG 6200 Evolutionary Genomics of Bacteria**

Spring. 1 credit. M. Stanhope.

Comparative genomics of bacteria is a valuable approach to deriving information on pathogenesis, antibiotic resistance, host adaptation, and genome evolution. This course provides an evolutionary perspective on comparative bacterial genomics, focusing in particular on pathogens of human and agricultural importance. The course will include lectures, discussion of relevant scientific literature, and a bioinformatics session.

**BIOMG 6310 Protein Structure, Dynamics, and Function**

Fall. 3 credits. Prerequisites: BIOMG 3300, or 3330, or 3350, or 3310/3320 and organic chemistry. Recommended: physical chemistry course. S-U or letter grades. Lec. L. Nicholson.

Presentations on the basic principles of protein structure, dynamics, and function. Specific topics include protein stability, dynamics, evolution, molecular recognition, basic enzyme kinetics, and spectroscopic tools for studying proteins.

**BIOMG 6330 Biosynthesis of Macromolecules**

Fall. 2 credits. Prerequisite: BIOMG 3300, or 3330, or 3350, or 3310/3320. Recommended: BIOMG 2810. Lec.

J. W. Roberts and D. B. Wilson. Synthesis of DNA, RNA, and proteins, and regulation of gene expression.

**BIOMG 6360 Functional Organization of Eukaryotic Cells**

Spring. 3 credits. Prerequisites: BIOMG 3300, or 3330, or 3350, or 3310/3320, and 4320, or equivalents. Lec. W. J. Brown.

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 BIOMG 4370 and 6390, this course provides broad coverage of the cell biology subject area.

**BIOMG 6380 Filamentous Fungal Genomics and Development (also PLPA 6380)**

Spring, weeks 9-12. 1 credit. Prerequisite: BIOMG 2810 or equivalent, or permission of instructor. Letter grades only. Lec. Offered alternate years. B. G. Turgeon. For description, see PLPA 6380.

**BIOMG 6390 The Nucleus**

Spring. 2 credits. Prerequisite: BIOMG 3300 or 3330 or 3350 or 3310/3320, or equivalent. Recommended: BIOMG 2810. Lec. J. T. Lis.

Lectures on topics of eukaryotic genome organization, chromatin structure, regulation of gene expression, RNA processing, the structure and movement of chromosomes, and nuclear export and import. Covers the structure and function of the nucleus at the molecular and cell biological levels.

**BIOMG 6410 Laboratory in Plant Molecular Biology (also BIOPL 6410)**

Fall. 4 credits. Prerequisites: BIOMG 2810 or equivalent, BIOMG 3300 or 3330 or 3350 or 3310 or equivalent, and permission of instructor. S-U grades by permission of instructor. Lab. M. R. Hanson, J. Nasrallah, K. Van Wijk, and staff.

For description, see BIOPL 6410.

**[BIOMG 6870 Developmental Genetics**

Spring. 2 credits. Limited to 30 students. Prerequisites: BIOMG 2810 and 3850 or equivalents. Letter grades. Lec TBA. Offered alternate years; next offered 2011-2012. M. F. Wolfner.

Course focuses on methods of genetic analysis to understand mechanisms of development. Lectures and problem sets are based on scientific literature, primarily of fruitflies, nematodes, mice, and zebrafish.]

**BIOMG 7300 Protein NMR Spectroscopy (also VETMM 7070)**

Spring. 2 credits. Prerequisites: CHEM 3890 and 3900, or 2870 and 2880, or permission of instructor. S-U or letter grades. Offered alternate years. Lec. L. K. Nicholson and R. E. Oswald.

Students acquire the tools necessary for understanding multidimensional NMR of proteins. NMR fundamentals and schemes for magnetization transfer, water suppression, decoupling, and others are presented.

**BIOMG 7380 Macromolecular Crystallography (also CHEM 7880)**

Spring. 3 credits. Prerequisite: permission of instructor. Lec. S. E. Ealick.

For description, see CHEM 7880.

**BIOMG 7510 Ethical Issues and Professional Responsibilities**

Spring. 1 credit. Prerequisite: graduate students beyond first year. S-U grades only. Organizational meeting first W of semester. Sem. P. Hinkle.

Ethical issues in research and the professional responsibilities of scientists are discussed based on readings and occasional lectures. The topics are intended to cover the requirements for ethical training of graduate students on training grants and follow the recommendations of the Office of Research Integrity.

**BIOMG 7800 Current Topics in Genetics and Development**

Fall and spring. 1 credit; may be repeated for credit. Limited to 20 students. Primarily for graduate students; priority given to majors in field of genetics. Prerequisite: for undergraduates, written permission of instructor. No auditors. S–U grades only. Staff.

**BIOMG 7810 Problems in Genetics and Development**

Fall. 2 credits. Prerequisite: first-year graduate students in field of genetics and development. Disc TBA. Staff.

Introduction to the research literature in selected areas through weekly problem sets and discussions.

**BIOMG 7860 Research Seminar in Genetics and Development**

Fall and spring. 1 credit. Requirement for, and limited to second-year and beyond graduate students in genetics and development. S–U grades only. 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.

**BIOMG 7870 Seminar in Genetics and Development**

Fall and spring. 1 credit. Prerequisite: 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.

**BIOMG 7940 Current Topics in Biochemistry**

Fall or spring. 0.5 or 1 credit for each topic; may be repeated for credit. Prerequisite: BIOMG 3300, or 3330, or 3350, or 3310/3320 or equivalent. S–U grades only. Staff.

Lectures and seminars on specialized topics. Topics for fall and spring to be announced in the course and time roster published at the beginning of each semester or the department mini-courses web site, [www.mbg.cornell.edu/cals/mbg/about/courses/mini-courses.cfm](http://www.mbg.cornell.edu/cals/mbg/about/courses/mini-courses.cfm).

**BIOMG 8300 Biochemistry Seminar**

Fall or spring. 0 credits. Prerequisite: graduate students majoring in field of biochemistry, molecular and cell Biology. Lec open to everyone. V. Vogt.

Lectures on current research in biochemistry, presented by distinguished visitors and staff members.

**BIOMG 8310 Advanced Biochemical Methods I**

Fall. 6 credits. Requirement for, and limited to, first-year graduate students in field of biochemistry, molecular and cell biology. S–U grades only. Lab and disc.

Organizational meeting first F of semester 10:10. A. W. Grimson and J. A. Pleiss.

The first half of this course comprises an intensive laboratory covering fundamental aspects of modern molecular biology and cell biology. The second half comprises research in the laboratory of a professor chosen by the student (see BIOMG 8320). Students must enroll separately for each half.

**BIOMG 8320 Advanced Biochemical Methods II**

Spring. 6 credits. Requirement for, and limited to, first-year graduate students in field of biochemistry, molecular and cell biology. S–U grades only. Lab. V. M. Vogt and 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 advisor.

**BIOMG 8330 Research Seminar in Biochemistry**

Fall or spring. 1 credit each semester; may be repeated for credit. Requirement for, and limited to, second-, third-, and fourth-year graduate students majoring in field of biochemistry, molecular and cell biology. S–U grades only. V. M. Vogt.

Each student presents one seminar per year on his or her thesis research and then meets with instructors and thesis committee members for evaluation.

**BIOMG 8340 Quantitative Biology for Molecular Biology and Genetics**

Spring. 2 credits. Prerequisite: first-year Ph.D. students in the graduate fields of biochemistry, molecular and cell biology, or genetics and development, all others with permission of instructor. Letter grades only. Lec. J. A. Pleiss and D. I. Shalloway.

Focuses on mathematical and statistical tools needed to analyze experimental data in molecular biology and genetics using examples from the literature. Provides a foundation for individual study of the quantitative techniques needed in individual research programs.

**BIOMG 8370 Problems in Biochemistry, Molecular, and Cell Biology**

Fall. 2 credits. Prerequisite: first-semester Ph.D. students in graduate field of biochemistry, molecular and cell biology. Letter grades. M. B. Smolka.

Introduction to the research literature in selected areas through weekly problem sets and discussion.

**BIOMG 8380 Scientific Communication and Quantitation in Biochemistry, Molecular and Cell Biology (BMCB)**

Spring. 1 credit. Prerequisite: second-year graduate students majoring in field of biochemistry, molecular and cell biology; all others with permission of instructor. S–U grades only. D. I. Shalloway.

An interactive seminar to develop scientific writing (grant proposals and papers) and speaking (research talks) skills needed to support a career in scientific research. Students will begin the preparation of a mock postdoctoral research grant proposal.

**Related Courses in Other Departments**

Lipids (NS 6020)

Undergraduate Research in Biology (BIOG 4990)

Advanced Plant Genetics (PLBR 6060)

Biosynthesis of Macromolecules (BIOMG 6330)

Concepts and Techniques in Plant Molecular Biology (BIOPL 4831)

Current Topics in Biochemistry (BIOMG 7940)

Evolutionary Biology (BIOEE 1780)

Laboratory in Molecular Biology and Genetic Engineering of Plants (BIOPL 3431)

Laboratory in Plant Molecular Biology (BIOPL 6410)

Light Signal Transduction in Plants (BIOPL 4829)

Molecular Aspects of Plant Development (BIOPL 4834)

Molecular Biology and Genetic Engineering of Plants (BIOPL 3430)

Molecular Biology of Plant Organelles (BIOPL 4825)

Molecular Breeding (BIOPL 4835)

Molecular Plant-Microbe Interactions (BIOPL 4823)

Molecular Plant-Pathogen Interactions I and II (BIOPL 4821–4822)

Plant Biotechnology (BIOPL 4826)

Plant Cell Walls: Structure to Proteome (BIOPL 4827)

Plant Cytogenetics (PLBR 4460)

Plant Gene Evolution and Phylogeny (BIOPL 4824)

Plant Genome Organization (PLBR/BIOPL 4833)

Plant Senescence (BIOPL 4836)

Proteomics and Protein Mass Spectrometry in Biology (BIOPL 4832)

The Nucleus (BIOMG 6390)

Undergraduate Research in Biology (BIOG 4990)

Molecular Neurobiology BIONB 4200/7200 (also BIOMG 4350/7940)

Introduction to Research Methods in Biology (BIOG 2990)

**MICROBIOLOGY (BIOMI)****BIOMI 1120 Microbes, the Earth, and Everything (also CSS 1120)**

Fall. 3 credits. D. Buckley and E. Angert. For description, see CSS 1120.

**BIOMI 1250 Biology Seminar**

Fall and spring. 1–2 credits. Prerequisite: none. S–U grades only. Staff.

A first-year seminar designed for students with a strong interest in research. Students will interact with faculty while learning to read and evaluate scientific publications on current biological topics. Multiple topics and sections will be offered each semester.

**BIOMI 1720 Bioscientific Terminology (also CLASS 1692)**

Summer and winter. 3 credits. Letter grades only.

For description, see CLASS 1692.

**BIOMI 2500 Microbial Oceanography**

Spring. 3 credits. Prerequisites: one of the following: BIOEE/BIOG 1610, 1780 or EAS 1540. Letter grades only. I. Hewson.  
Provides sophomore- and junior-level students exposure to the crucial role of marine microorganisms in ocean function. Students will gain an appreciation for the diversity of marine microorganisms, their broad physiology, and how it relates to ecosystem function. Will also cover diseases of marine organisms and human pathogenic microorganisms in the ocean.

**BIOMI 2900 General Microbiology Lectures**

Fall, spring, or summer (six-week session). 3 credits. Prerequisites: two semesters majors-level biology and two semesters college-level chemistry, or equivalent. Highly recommended: concurrent registration in BIOMI 2910. W. C. Ghiorse.  
Comprehensive overview of the biology of microorganisms, with emphasis on bacteria. Topics include microbial cell structure and function, physiology, metabolism, genetics, diversity, and ecology. Also covers applied aspects of microbiology such as biotechnology, the role of microorganisms in environmental processes, and medical microbiology. 4-credit option involves one discussion per week led by faculty in the Department of Microbiology and will involve readings and a writing assignment. Students may not pre-register for 4-credit option: Interested students complete an application form on first day of class (enrollment will be limited to 20 students).

**BIOMI 2910 General Microbiology Laboratory**

Summer (six-week session). 2 credits. Pre- or corequisite: BIOMI 2900. S. M. Merkel.  
Study of the basic principles and techniques of laboratory practice in microbiology, and fundamentals necessary for further work in the subject.

**BIOMI 2911 General Microbiology Laboratory**

Fall or spring. 2 credits. Pre- or corequisite: BIOMI 2900. S. M. Merkel.  
Study of the basic principles and techniques of laboratory practice in microbiology, and fundamentals necessary for further work in the subject.

**BIOMI 2920 General Microbiology Discussion**

Spring. 1 credit. Pre- or corequisite: BIOMI 2900. S-U grades only. Staff.  
Series of discussion groups in specialized areas of microbiology to complement BIOMI 2900.

**BIOMI 3080 Field Microbial Ecology (also BIOSM 3080)**

Summer. 4 credits.  
For description, see BIOSM 3080.

**BIOMI 3210 The Normal Microbes of the Human Body in Health and Disease**

Spring. 3 credits. Prerequisites: BIOMI 2900 or permission of instructor. Letter grades only. R. Ley.  
The human body is coated with microbes outnumbering "our own" cells 10 to 1, providing us with capacities we have not had to evolve on our own. This course will introduce the microbes of the human body, discuss their origins, adaptations to the body, molecular interactions, and associations with health and disease.

**BIOMI 3310 General Parasitology (also BIOSM 3310)**

Spring. 2 credits. Prerequisites: zoology or biology course; any of the following: BIOEE 1610, 1780, 2640, 2670, 2740; NS 2750; EAS 1700; BIOMI 2900, BIOG 1106, 1610, 1780 or one semester college-level biology or majors-level biology, or equivalent courses. Letter grades only. D. D. Bowman.  
For description, see BIOSM 3310.

**BIOMI 3500 Marine Microbiology**

Spring. 3 credits. Prerequisites: BIOEE/BIOG 1610, 1780, or EAS 1540. Letter grades only. I. Hewson.  
BIOMI 3500 will provide marine microbiological background to students interested in pursuing graduate-level degrees in the ocean sciences. Students enrolled in BIOMI 3500 will take the lecture component of BIOMI 2500 (Microbial Oceanography) but will complete additional assignments at the advanced level (NSF proposal, literature review paper, and in-class seminar).

**BIOMI 3910 Advanced Microbiology Laboratory**

Fall. 3 credits. Prerequisites: BIOMI 2900, 2910, or 2911 and BIOMG 3300, 3310, 3330, or 3350. Priority given to biological sciences students in microbiology program of study. E. R. Angert, J. P. Shapleigh, and S. H. Zinder.  
An introduction to advanced experimental methods in microbiology. Students will gain experience with a variety of cutting-edge technologies used to characterize genetic, physiological, and structural aspects of microbes. These skills will be utilized during the isolation and characterization of bacteria isolated from diverse habitats as well as during isolation of mutants of an environmental isolate.

Students will gain experience with a variety of cutting-edge technologies used to characterize genetic, physiological, and structural aspects of microbes. These skills will be utilized during the isolation and characterization of bacteria isolated from diverse habitats as well as during isolation of mutants of an environmental isolate.

**BIOMI 3940 Applied and Food Microbiology (also FDSC 3940)**

Fall. 3 credits. Prerequisites: BIOMI 2900-2910. C. A. Batt.  
For description, see FDSC 3940.

**[BIOMI 3970 Environmental Microbiology: Evolution, Biogeochemistry, Microbial Ecology (also CSS 3970)]**

Spring. 3 credits. Prerequisites: BIOMI 2900. Recommended: BIOEE/BIOG 1610, NTRES 3030, or permission of instructor. Offered alternate even-numbered years; next offered 2011-2012. E. L. Madsen.  
Discusses the functional role and evolution of microorganisms in ecologically and environmentally significant processes in relation to past and present environmental conditions on Earth.]

**[BIOMI 4040 Pathogenic Bacteriology (also BIOSM 4040)]**

Spring. 2 or 3 credits; 3 credits with lec and sem. Seminar required for graduate students. Maximum enrollment for seminar portion 15. Prerequisites: BIOMI 2900 and 2910 or 2911; for undergraduates, permission of instructor. Highly recommended: BIOG 3050. Offered alternate even years; next offered 2011-2012. Letter grades only. D. Debbie.  
For description, see BIOSM 4040.]

**BIOMI 4090 Principles of Virology (also BIOSM/PLPA 4090)**

Fall. 3 credits. Prerequisites: BIOMI 2900, 2910, or 2911 or permission of instructor. Recommended: BIOMG 3300-3320, or 3350, 4320. Letter grades only. S. G. Lazarowitz, N. Osterrieder, and J. Parker.  
For description, see BIOSM 4090.

**BIOMI 4140 Prokaryotic Diversity**

Spring. 3 credits. Prerequisites: BIOMI 2900 and 2910 or 2911. Recommended: BIOMG 3300, 3310, 3330, or 3350. Offered alternate odd-numbered years. S. H. Zinder.  
Consideration of the evolutionary biology, physiology, ecology, genetics, and practical potential of important groups of prokaryotes. Topics include prokaryotic phylogeny, the evolution of diverse mechanisms of energy conservation, fixation of carbon and nitrogen, and adaptation to extreme environments.

**[BIOMI 4160 Bacterial Physiology**

Spring. 3 credits. Prerequisites: BIOMI 2900, 2910, or 2911 and BIOMG 3300, 3310, 3330, or 3350 or equivalents. Offered alternate even years; next offered 2011-2012. J. P. Shapleigh.  
Course will cover the basic structures and metabolic processes common to most bacteria. Emphasis will be on structural organization of bacteria and understanding physiological adaptations to different growth conditions.]

**BIOMI 4200 Microbial Genomics**

Spring. 2 credits. Prerequisites: BIOMI 2900, BIOMG 2810, BIOMG 3300, 3310, 3330, or 3350 or equivalents. Offered alternate odd-numbered years. J. Peters and J. D. Helmann.  
Genomic information is revolutionizing biology. This course discusses 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 4310 Medical Parasitology (also BIOSM 4310)**

Fall. 2 credits. Prerequisites: zoology or biology course; any of the following: BIOEE 1610, 1780, 2070, 2630, 2640, 2670, 2740; NS 2750; BIOMI 2900, 3970; EAS 1700; BIOG 1105, 1106, 1680, 1780, or one semester college-level biology or majors-level biology or equivalent course. Letter grades only. D. D. Bowman.  
For description, see BIOSM 4310.

**BIOMI 4480 Symbiotic Associations: Evolution and Ecology (also PLPA 4480)**

Spring. 3 credits. Prerequisites: two semesters majors-level biology or equivalent or permission of instructor. Letter grades only. T. E. Pawlowska.  
For description, see PLPA 4480.

**[BIOMI 4823 Molecular Plant-Microbe Interactions (also BIOPL/PLPA 4823)]**

Spring. 1 credit. Prerequisites: BIOMG 2810, BIOMG 3300, 3310, 3330, or 3350, and BIOPL 4830 or equivalents. S-U or letter grades. Offered alternate even years; next offered 2011-2012. S. C. Winans.  
For description, see BIOPL 4823.]

**BIOMI 4850 Bacterial Genetics (also BIOMG 4850)**

Fall. 2 or 3 credits; optional 1 credit for registered students with permission of instructor to review literature. Prerequisite: BIOMG 2810. Recommended: BIOMI 2900 and BIOMG 3300, 3310, 3320, 3330, or 3350. J. E. Peters.

Students gain a detailed understanding of how bacteria maintain and pass on genetic information with a strong focus on the bacterium *Escherichia coli*. They discover the processes by which bacteria evolve through different mutations and the exchange of genetic information. The course explores how genes are regulated efficiently through negative and positive regulation and by global regulatory mechanisms. Upon completion of the course students should understand the tools used to manipulate bacterial genomes for the understanding of bacteria and other living organisms.

**BIOMI 4980 Teaching Experience**

Fall or spring. 1–4 credits. Limited enrollment. Prerequisites: previous enrollment in course to be taught or equivalent. Note: Arts students may not count this course toward graduation but may, 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 or letter grades by permission of the 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.

**BIOMI 6080 Genomics of Bacterium-Host Interactions (also PLPA 6080)**

Fall, second half of semester. 1 credit. Prerequisites: BIOMI 2900 or equivalent or permission of instructor. S–U or letter grades. Offered alternate even years. A. Collmer and S. Winans.

For description, see PLPA 6080.

**BIOMI 6100 Introduction to Chemical and Environmental Toxicology (also TOX 6100)**

Fall. 3 credits. Prerequisite: graduate standing in field or permission of instructor. Letter grades. Offered alternate even years. A. Hay.

Introduction to the general principles of toxicology including the sources, mechanisms, and targets of toxic agents. Gives special attention 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 6430 Veterinary Perspectives on Pathogen Control in Animal Manure (also VTMED/BEE 6430)**

Spring, eight weeks. 2 credits. Prerequisite: third- and fourth-year veterinary students.

Letter grades only. D. D. Bowman.

For description, see VTMED 6430.

**BIOMI 6901 Prokaryotic Biology: Microbial Structure and Function**

Fall, 4 weeks/8 lec. 1 credit. J. P. Shapleigh. Discusses 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.

**BIOMI 6902 Prokaryotic Biology: Environmental Microbiology**

Fall, 4 weeks/8 lec. 1 credit. E. L. Madsen. Core course of concepts, methods, and current literature that reveals the multidisciplinary nature of environmental microbiology and its relationship to prokaryotic biology. Discusses the crucial roles that microorganisms play in catalyzing biogeochemical reactions throughout the biosphere.

**BIOMI 6903 Prokaryotic Biology: Microbial Physiology/Diversity**

Fall, 4 weeks/8 lec. 1 credit. S. H. Zinder. Reviews the major energy-conserving modes of metabolism and their phylogenetic distributions among both bacteria and archaea. Topics include phylogenetic analysis, fermentation, respiration, photosynthesis, pathways of carbon and nitrogen fixation, and evolution of the three domains of life.

**BIOMI 6904 Prokaryotic Biology: Microbial Genetics**

Spring, 4 weeks/8 lec. 1 credit. J. D. Helmann. Reviews the fundamental concepts of microbial genetics including mutations and their analysis, plasmids, conjugation, transformation, transduction, transposition, recombination, repair, and mutagenesis.

**BIOMI 6905 Prokaryotic Biology: Microbial Pathogenesis**

Spring, 4 weeks/8 lec. 1 credit. S. C. Winans. 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 include bacterial pathogens of both animals and plants.

**BIOMI 6906 Prokaryotic Biology: Viral Diversity and Ecology**

Spring, 4 weeks/8 lec. 1 credit. I. Hewson. This course is intended to give graduate students an introduction to virology in an environmental setting. It will provide an overview of viral biology and lifestyles, infection kinetics, and then provide an appreciation for different types of viruses including uncultivated viruses recovered through metagenomics.

**BIOMI 6990 Toxicology Journal Club Sec 01—Environmental Toxicology (TOX 6990)**

Spring. 1 credit. Required for toxicology students until post A exam. A. G. Hay.

**BIOMI 7250 Mechanisms of Microbial Pathogenesis (also VETMI 7250)**

Spring. 3 credits. Prerequisites: for undergraduates, written permission of instructor; BIOMI 4040, 4090, or equivalent. Highly recommended: completion of two of the three courses. D. Debbie, M. Hesse, H. Marquis, J. Parker, M. Scidmore, and G. Whittaker.

For description, see VETMI 7250.

**BIOMI 7910 Advanced Topics in Microbiology**

Fall or spring. 1 credit; may be repeated for credit. Prerequisite: graduate standing in microbiology. S–U grades only. E. R. Angert. Reading and presentation by graduate students of current literature in selected areas of modern microbiology.

**BIOMI 7960 Current Topics in Microbiology**

Fall and spring. 0.5 or 1 credit for each topic; may be repeated for credit. Primarily for graduate students in microbiology. Prerequisite: upper-level courses in microbiology. S–U grades only. Lec. Staff. Lectures and seminars on special topics in microbiology.

**BIOMI 7970 Scientific Communication Skills**

Fall and spring. 1 credit each semester. Requirement for graduate students in graduate field of microbiology for first two semesters; third semester optional. S–U grades only. 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 are critically evaluated by the instructor. Feedback for improving the presentation and peer evaluations are emphasized.

**BIOMI 7980 Graduate Research Seminar in Microbiology**

Fall and spring. 1 credit each semester. Requirement for graduate students in graduate field of microbiology. S–U grades only. Staff. All graduate students in the field of microbiology are required to attend and present a seminar concerning their research at least once each year.

**BIOMI 7990 Microbiology Seminar**

Fall and spring. Requirement for all graduate students in graduate field of microbiology. Open to all who are interested. Staff.

**Related Courses in Other Departments**

- Advanced Food Microbiology (FDSC 6070)
- Advanced Immunology Lectures (VETMI/BIOMS 7050)
- Advanced Work in Bacteriology, Virology, or Immunology (VETMI 7070)
- Applied and Food Microbiology, Lectures (FDSC 3940)
- Basic Immunology, Lectures (BIOMS 3150)
- Current Topics in Oomycete Biology (PLPA 6440)
- Food Microbiology, Laboratory (FDSC 3950)
- Immunology of Infectious Diseases (VETMI/BIOMS 7190)
- Introduction to Scanning Electron Microscopy (BIOPL 4010)
- Fungi (PLPA 3090)
- Light and Video Microscopy for Biologists (BIOPL 4500)

Limnology: Ecology of Lakes, Lectures (BIOEE 4570)

Magical Mushrooms, Mischievous Molds (PLPA 2010)

Microbiology for Environmental Engineering (CEE 4510)

Plant Virology (PLPA 6450)

Principles of Biogeochemistry (BIOEE 6680)

## MEDICAL SCIENCE (BIOMS)

### **BIOMS 2140 The Biological Basis of Sex Differences (also BSOC 2141, BIOAP/FGSS 2140)**

Fall. 3 credits. Prerequisite: one college-level biology course or permission of instructor. S-U or letter grades. Offered alternate years. J. E. Fortune.  
For description, see BIOAP 2140.

### **BIOMS 3110 Introductory Animal Physiology (also BIOAP 3110, VTBS 3460)**

Fall. 3 credits. Prerequisites: BIOG 1500 Investigative Biology Laboratory and BIOG 1440 Comparative Physiology; or one year of college biology; one year chemistry and mathematics or equivalent AP credit. Recommended: previous or concurrent physics course. S-U or letter grades by permission of instructor. Evening prelims. E. R. Loew.  
For description, see BIOAP 3110.

### **BIOMS 3150 Basic Immunology**

Fall. 3 credits. Highly recommended: basic courses in microbiology, genetics, and biochemistry. S-U or letter grades. J. A. Appleton.  
Survey of immunology, with emphasis on the cellular and molecular bases of the immune response.

### **BIOMS 3160 Cellular Physiology (also BIOAP 3160)**

Spring. 3 credits. Pre- or corequisite: BIOMG 1350 Principles of Cell and Developmental Biology or BIOMG 3300 or 3310 and 3320 or 3330. Letter grades only. Evening prelims. A. Quaroni.  
For description, see BIOAP 3160.

### **BIOMS 3190 Animal Physiology Experimentation (also BIOAP 3190)**

Fall. 4 credits. Pre- or corequisite: BIOG 3110. For pre-med, pre-vet juniors and seniors, and graduate students interested in biomedical science. Letter grades only. E. R. Loew, N. A. Lorr, and staff.  
For description, see BIOAP 3190.

### **BIOMS 3310 General Parasitology (also BIOMI 3310)**

Spring. 2 credits. Prerequisites: zoology or biology course; any of the following: BIOEE 1610, 1780, 2640, 2670, 2740; NS 2750; EAS 1700; BIOMI 2900, BIOG 1106, or one semester college-level biology or majors-level biology, or equivalent courses. Letter grades only. D. D. Bowman.  
This course is an introduction to the basic animal parasites, stressing systematics, taxonomy, general biology, ecological interactions, and behavior of non-medically important groups. Introduces the major animal parasite groups: protozoan, nematode, platyhelminth, acanthocephalan, annelid, and arthropod.

### **BIOMS 3350 Wildlife Parasitology**

Summer. 2 credits. Prerequisites: one semester college level biology or majors-level biology, or equivalent. Letter grades only. D. D. Bowman and A. Lucio-Forster.  
Parasites of wildlife, mainly of more studied hosts. Emphasis on morphology, biology, diversity, and effects on host and environment. Examples of parasites of invertebrates, fish, amphibia, reptiles, birds, and mammals. Objective is an appreciation of the diversity of parasites and to introduce the impact that these parasites have on biology.

### **BIOMS 4040 Pathogenic Bacteriology (also BIOMI 4040)**

Spring. 2 or 3 credits; 3 credits with lec and sem. Seminar required for graduate students. Maximum enrollment for seminar portion 11. Prerequisites: BIOMI 2900 and 2910. Letter grades only. D. P. Debbie.  
Course in medical microbiology, presenting the major groups of bacterial pathogens important to human and veterinary medicine. Emphasizes infection and disease pathogenesis. Topics include disease causality; interactions of host, pathogen, and environment, including immunity to bacteria; 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 levels.

### **BIOMS 4090 Principles of Virology (also BIOMI/PLPA 4090)**

Fall. 3 credits. Prerequisites: BIOMI 2900 and 2910 or permission of instructor. Recommended: BIOMG 3300-3320, 4320. S. Lazarowitz, N. Osterrieder, and J. Parker.  
Covers the principles of virology, focusing mainly on animal viruses but also including plant viruses and bacteriophage. Topics include the classification of viruses, virus entry, genome replication and assembly, and virus pathogenesis. Particular emphasis is placed on virus-host cell interactions and common features between different viral families.

### **BIOMS 4130 Histology: The Biology of the Tissues (also BIOAP 4130)**

Spring. 4 credits. Prerequisite: BIOMG 1350 Principles of Cell and Developmental Biology. Recommended: BIOMG 3300 or 3310, or equivalent. S-U or letter grades. S. Suarez and L. Mizer.  
For description, see BIOAP 4130.

### **BIOMS 4160 Cell Physiology and Genomics Laboratory (also BIOAP 4160)**

Spring. 4 credits. Limited to 24 students. Pre- or corequisite: BIOAP 3160 or BIOMG 4320 or permission of instructor OR BIOMG 1350. For pre-med, pre-vet, juniors, seniors, and graduate students interested in biomedical science. Letter grades only. H.-H. Chuang, N. A. Lorr, and staff.  
For description, see BIOAP 4160.

### **BIOMS 4310 Medical Parasitology (also BIOMI 4310)**

Fall. 2 credits. Prerequisites: zoology or biology course; any of the following: BIOEE 1610, 1780, 2070, 2630, 2640, 2670, 2740; NS 2750; BIOMI 2900, 3970; EAS 1700, BIOG 1105, 1106, 1680, 1780, or one semester college-level biology or majors-level biology, or equivalent course. Letter grades only. D. D. Bowman.  
Systematic study of arthropod, protozoan, and helminth parasites of public health importance,

with emphasis on epidemiologic, clinical, and zoonotic aspects of these parasitisms.

### **BIOMS 4580 Mammalian Physiology (also BIOAP 4580)**

Spring. 3 credits. Auditors allowed. Prerequisite: BIOAP 3110 or BIOG 1440 Comparative Physiology, with permission of instructor. Recommended for biological sciences majors, pre-med and pre-vet students, and beginning graduate students in physiology, nutrition, and animal science. Letter grades only. Evening prelims. K. W. Beyenbach.  
For description, see BIOAP 4580.

### **[BIOMS 4750 Mechanisms Underlying Mammalian Developmental Defects (also BIOAP/NS 4750)**

Spring. 3 credits. Prerequisites: BIOMG 3300, 3310/3320, or 3330 (may be taken concurrently). S-U or letter grades. Offered alternate years; next offered 2011-2012. D. Noden and P. Stover.  
For description, see BIOAP 4750.]

### **[BIOMS 4890 Mammalian Embryology (also BIOAP/BIOMG 4890)**

Spring. 3 credits. Prerequisite: introductory biology. S-U or letter grades. Evening prelims. Offered alternate years; next offered 2011-2012. D. M. Noden.  
For description, see BIOAP 4890.]

### **BIOMS 6110 Genome Maintenance Mechanisms**

Fall. 1 credit. Prerequisite: BIOMG 2810, as well as BIOMG 3300, or 3310, or 3330, or 3350. S-U or letter grades. R. Weiss.  
This course focuses on the molecular mechanisms for preserving genomic integrity in eukaryotes. Topics discussed include sources of mutation, DNA repair, and cell cycle checkpoints. Also addressed is how genome maintenance impacts genome plasticity and evolution, as well as the relationship between genomic instability and disease, including cancer.

### **[BIOMS 7050 Advanced Immunology (also VETMI 7050)**

Spring. 3 credits. Prerequisite: basic immunology course or permission of instructor. Letter grades only. Offered even-numbered years; next offered 2011-2012. C. Leifer and staff.  
For description, see VETMI 7050.]

### **BIOMS 7190 Immunology of Infectious Diseases (also VETMI 7190)**

Spring. 2 credits. Prerequisite: basic immunology course or permission of instructor. S-U or letter grades. Offered odd-numbered years. M. Bynoe and staff.  
For description, see VETMI 7190.

## NEUROBIOLOGY AND BEHAVIOR (BIONB)

### **BIONB 1110 Brain Mind and Behavior (also PSYCH/COGST 1110)**

Spring. 3 credits. Prerequisite: none. Intended for freshmen and sophomores in humanities and social sciences; not open to juniors and seniors. Not recommended for psychology majors; biology majors may not use for credit toward major. Letter grades only. Planned M W F 9:05. E. Adkins-Regan and R. R. Hoy.  
For description, see COGST 1110.

**[BIONB 1220 FWS: Special Topics in Neurobiology and Behavior**

Fall and spring, 3 credits. Prerequisite: permission of Knight Writing Program; freshman standing. Letter grades only. Staff. For description, see John S. Knight Institute for Writing in the Disciplines. First-Year Writing Seminars.]

**BIONB 1250 Biology Seminar**

Fall and spring, 1–2 credits. Prerequisite: none. S–U grades only. Staff. A first-year seminar designed for students with a strong interest in research. Students will interact with faculty while learning to read and evaluate scientific publications on current biological topics. Multiple topics and sections will be offered each semester.

**BIONB 2210 Neurobiology and Behavior I: Introduction to Behavior**

Fall, 3, 4, or 5 credits; 4 credits with one disc per week; 5 credits with two disc per week and participation in Writing in the Majors program; 4- or 5-credit option required of students in neurobiology and behavior program of study. Limited to 15 students per 4-credit disc. Priority given to students studying neurobiology and behavior. Limited to 12 students in 5-credit option (students may not preregister for 5-credit option; interested students complete application form on first day of class). Not open to freshmen. Prerequisite: two majors-level biology courses. May be taken independently of BIONB 2220. S–U or letter grades. Planned M W F 12:20; disc TBA. T. D. Seeley and staff.

General introduction to the field of animal behavior. Topics include evolution and behavior, behavioral ecology, sociobiology, chemical ecology, communication, orientation and navigation, and hormonal mechanisms of behavior.

**BIONB 2213 Neurobiology and Behavior II: Introduction to Behavior**

Summer, six-week session. 3 or 4 credits; 4 credits with one disc per week. Limited to 30 students. Prerequisite: two majors-level biology courses. S–U or letter grades. Course fee: none. Planned M–F TBA. Staff. General introduction to the field of animal behavior. Topics include evolution and behavior via natural selection, genes and behavior, behavioral ecology, sociobiology, communication, cognition, hormonal mechanisms of behavior, and topics in Darwinian medicine.

**BIONB 2220 Neurobiology and Behavior II: Introduction to Neurobiology**

Spring, 3, 4, or 5 credits; 4 credits with one disc per week and written projects; 5 credits with two disc per week and participation in Writing in the Majors program; 4- or 5-credit option required of students in neurobiology and behavior program of study. Limited to 15 students per 4-credit disc. Priority given to students studying neurobiology and behavior. Limited to 12 students in 5-credit option (students may not preregister for 5-credit option; interested students complete application form on first day of class). Not open to freshmen. Prerequisite: two majors-level biology courses and one year chemistry. May be taken independently of BIONB 2210. S–U or letter grades. Planned M W F 12:20; disc TBA. A. H. Bass and staff.

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 3220 Hormones and Behavior (also PSYCH 3220/7220)**

Fall, 3 credits. Limited to 60 students. Prerequisites: junior or senior standing; any one of the following: PSYCH 2230 or BIONB 2210 or 2220 or two majors-level biology courses plus psychology course. Two lec plus sec in which students read and discuss original papers in the field, give oral presentation, and write term paper. Letter grades only. Graduate students, see PSYCH 7220. Planned M W F 11:15. E. Adkins-Regan.

For description, see PSYCH 3220.

**[BIONB 3230 Methods in Animal Behavior**

Fall, 4 credits. Limited to 24 students. Prerequisite: BIONB 2210. Letter grades only. Offered alternate years; next offered 2011–2012. Planned M W 1:25–4:25. Staff.

Hands-on lab/field course in methods for studying animal behavior. Topics include sound recording, videography radio-tracking, mapping, capture/marketing methods, and behavioral statistics.]

**BIONB 3240 Biopsychology Laboratory (also PSYCH 3240)**

Fall, 4 credits. Limited to 20 students. Prerequisites: junior or senior standing; PSYCH 2230 or BIONB 2210 or 2220, and permission of instructor. Planned T R 1:25–4:25. Letter grades only. T. J. DeVoogd.

For description, see PSYCH 3240.

**[BIONB 3250 Insect Behavior (also ENTOM 3250)**

Spring, 3 credits. Limited to 50 students. Prerequisite: ENTOM 2120 or BIONB 2210. Intended for juniors, seniors, and beginning graduate students. S–U or letter grades. Planned T R 10:10–11:25. Offered alternate years; next offered 2011–2012. L. S. Rayor.

For description, see ENTOM 3250.]

**BIONB 3280 Biopsychology of Learning and Memory (also PSYCH 3320/6320)**

Spring, 3 credits. Limited to 65 students. Prerequisites: two majors-level biology courses and either a biopsychology course or BIONB 2220. S–U or letter grades. Graduate students, see PSYCH 6320. Planned M W F 11:15. T. J. DeVoogd.

For description, see PSYCH 3320.

**[BIONB 3290 Ecology of Animal Behavior (also BIOSM 3290)**

Summer, 4 credits. Limited to 18 students. Prerequisite: two semesters of college-level biology or equivalent. Previous experience in psychology, animal behavior, or ecology also recommended but not essential. S–U or letter grades. Special two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. For more details and an application, contact SML office, G14 Stimson Hall. Daily lec, lab, and fieldwork for two weeks. Next offered summer 2012. SML faculty, oh,

For description, see BIOSM 3290.]

**BIONB 3300 Introduction to Computational Neuroscience (also PSYCH/COGST/BME 3300)**

Fall, 3 or 4 credits; 4 credits includes lab providing additional computer simulation exercises. Prerequisites: BIONB 2220 or permission of instructor. S–U or letter grades. Offered alternate years. Planned M W 2:55–4:10, lab TBA. C. Linster. Covers the basic ideas and techniques involved in computational neuroscience. 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 3400 Animal Orientation and Navigation**

Spring, 2 credits. Pre- or corequisite: BIONB 2210 and BIONB 2220 or permission of instructor. S–U or letter grades. Planned: T R 9:05. Offered alternate years; next offered 2011–2012. K. Adler.

In-depth coverage of the topic, including sensory cues and receptors, physiological basis, ecological context, and evolutionary aspects, with emphasis on current research.]

**BIONB 3690 Chemical Ecology (also BIOEE/ENTOM 3690)**

Spring, 3 credits. Prerequisites: one majors-level biology course and one semester introductory chemistry for majors or nonmajors or equivalents, or permission of instructor. S–U or letter grades. Planned M W F 11:15. J. Thaler, A. Kessler, A. Agrawal, and R. Raguso.

For description, see BIOEE 3690.

**[BIONB 3920 Drugs and the Brain**

Fall, 4 credits. Limited to 90 students. Prerequisites: BIONB 2220 or equivalent course in neurobiology by permission of instructor. Recommended: knowledge of biochemistry. S–U or letter grades. Planned T R 10:10–11:25; disc TBA. Offered alternate years; next offered 2011–2012. R. M. Harris-Warrick.

Introduction to neuropharmacology, emphasis on neural mechanisms of psychoactive drugs, including cocaine, heroin, psychedelics, marijuana, alcohol, and drugs for psychiatric treatment.]

**[BIONB 3960 Introduction to Sensory Systems (also PSYCH 3960/6960)**

Spring, 4 credits. Limited to 25 students. Prerequisites: two majors-level biology courses or biopsychology, plus second course in behavior, biopsychology, cognitive science, neuroscience, or perception; knowledge of elementary physics, chemistry, and behavior. S–U or letter grades. Planned T R 10:10–11:25. Offered alternate years; next offered 2011–2012. B. P. Halpern.

For description, see PSYCH 3960.]

**[BIONB 4130 Molecules of Social Behavior and Emotion**

Spring, 3 credits. Prerequisite: none. Letter grades only. Planned T R 10:10–11:25. Offered alternate years; next offered 2011–2012. D. P. McCobb.

The broad topic is molecular, neural, and endocrine mechanisms underlying emotions and motivations, behavioral choices and predispositions, and social drives.]

**BIONB 4200 Topics in Neurobiology and Behavior**

Fall and spring. Variable credit; may be repeated for credit. Primarily for undergraduates. S-U or letter grades. Staff. Courses on selected topics in neurobiology and behavior; can include lecture and seminar courses. See department office (W363 Mudd Hall) for offerings.

**BIONB 4210 Effects of Aging on Sensory and Perceptual Systems (also PSYCH 4310/6310)**

Fall. 3 or 4 credits; 4-credit option involves term paper or creation of relevant web site. Limited to 35 students. Prerequisites: one majors-level biology course or psychology, plus second course in perception, neuroscience, cognitive science, or biopsychology. S-U or letter grades. Planned T R 10:10-11:25.

B. P. Halpern.

For description, see PSYCH 4310.

**BIONB 4220 Modeling Behavioral Evolution**

Fall. 4 credits. Limited to 25 students. Prerequisites: BIONB 2210, one year calculus, course in probability or statistics, and permission of instructor; advanced undergraduates and graduate students. S-U or letter grades. Planned T R 2:55-4:10; computer lab TBA. Offered alternate years; next offered 2011-2012. H. K. Reeve.

Intensive lecture/computer lab course on modeling strategies in behavioral evolution. Population-genetic (including quantitative-genetic), static optimization, dynamic programming, and game-theoretic methods.]

**BIONB 4230 Cognitive Neuroscience (also PSYCH 4250/6250)**

Fall. 4 credits. Limited to 20 students. Prerequisites: two majors-level biology courses or biopsychology or neurobiology (e.g., PSYCH 2230 or BIONB 2210); and introductory course in perception, cognition, or language (PSYCH 1200, 2090, 2140, or 2150 essential). S-U or letter grades. Graduate students, see PSYCH 6250. Planned M W F 9:05. One lab in sheep brain dissection. Offered alternate years; next offered 2010-2011. B. L. Finlay.

For description, see PSYCH 4250.

**BIONB 4240 Neuroethology (also PSYCH 4240)**

Fall. 4 credits. Limited to 25 students. Prerequisites: BIONB 2220 or equivalent with permission of instructor. S-U or letter grades. Offered alternate years; next offered 2011-2012. C. D. Hopkins.

A comparative approach to the study of neural circuits involved in animal behavior: echolocation, sound localization, communication and signal recognition, bird song, central pattern generators, command neurons, and other topics.]

**BIONB 4250 Molecular Neurophysiology**

Fall. 3 credits. Prerequisite: BIONB 2220 or permission of instructor. S-U or letter grades. Planned T R 2:55-4:10. Offered alternate years; next offered 2011-2012. D. P. McCobb.

Structure/function of ion channels responsible for electrical signals, in e.g., learning/memory, sensing heat and jalapeños, epilepsy, directional plant growth.]

**[BIONB 4260 Animal Communication**

Spring. 4 credits. Limited to 50 students. Prerequisite: BIONB 2210. Letter grades only. Planned T R 2:55-4:10; disc TBA. Offered alternate years; next offered 2011-2012. Staff.

How and why do animals communicate (topics include signal evolution, environmental effects on communication, cooperation vs conflict signals, signal honesty, interspecific communication.)]

**BIONB 4270 Darwinian Medicine**

Fall. 4 credits. Limited to 30 students. Prerequisites: BIONB 2210 and BIOEE 2610 or 2780, and permission of instructor. Letter grades only. Planned T R 2:30-4:25. Offered alternate years. P. W. Sherman.

Writing-intensive advanced course for upper-division students interested in Darwinian Medicine. Lectures, discussions, and student presentations examine topics including adaptation, intra-genomic conflict, evolution of infectious disease, genetic diseases, virulence, sexuality, neuroendocrinology, stress, diet and disease, allergy, fever, morning sickness, lactose intolerance, depression and other mental illnesses, cancer, menopause, and senescence.

**BIONB 4280 Clinical Neurobiology**

Fall. 3 credits. Limited to 20 students. Prerequisites: two courses from BIONB 2220, BIOMG 2810, BIOMG 3300 or 3310; co-registration in one of the two is acceptable by permission of instructor. Open to advanced undergraduates. S-U or letter grades. Planned M W 2:30-4:25. Offered alternate years. R. Booker.

The goal of this course is to provide students with an appreciation of the current challenges facing researchers studying neurodegenerative diseases. The focus is on the etiology, epidemiology, cellular and molecular basis, and strategies for treating of a number of neurodegenerative diseases, including but not limited to Alzheimer's disease, Parkinson's disease, neural ischemia, depression, ADHD, eating disorders, and AIDS-related dementia. The course provides a health context that enriches the student's learning experience in other advanced courses in the biological sciences. Guest speakers include faculty from across the Ithaca campus and the Weill College of Medicine, Departments of Neurology and Neuroscience.

**[BIONB 4290 Olfaction and Taste: Structure and Function (also PSYCH 4290)**

Spring. 3 or 4 credits; 4-credit option requires term paper. Priority given to junior and senior psychology and biology majors and graduate students. Graduate students, see PSYCH 6290. Prerequisite: one 3000-level course in biopsychology or equivalent. S-U or letter grades. Planned T R 10:10-11:25. Offered alternate years; next offered 2011-2012. B. P. Halpern.

For description, see PSYCH 4290.]

**BIONB 4300 Experimental Molecular Neurobiology**

Spring. 4 credits. Limited to 12 students. Prerequisites: BIOMG 3300 or 3310. Recommended: BIOMG 2810. Letter grades only. Lab T (for times see www.nbb.cornell.edu/bionb430.shtml). Offered alternate years.

Experiments include PCR, cloning of DNA fragments, RNA purification, restriction digests, bacterial transformation, DNA sequencing, and protein interactions. Experiments emphasize how molecular techniques can be applied to studying neurobiological problems.

**[BIONB 4310 Genes and Behavior**

Spring. 3 credits. Limited to 50 students. Prerequisite: BIONB 2220. S-U or letter grades. Planned T R 2:55-4:10. Offered alternate years; next offered 2011-2012. J. R. Fetcho.

Genes influence how we behave. Explores current understanding of how genes influence the behavior of a variety of animals, including humans.]

**[BIONB 4320 Genetics and Evolution of Behavior**

Spring. 3 credits. Limited to 20 students. Prerequisite: BIONB 2210. Letter grades only. Planned T R 2:55-4:10. Offered alternate years; next offered 2012-2013. K. Shaw.

The astounding diversity of animal behaviors provides an endless source of fascination. This multidisciplinary course examines our current understanding of the evolution of such behavior, focusing on how and why behaviors evolve.]

**BIONB 4330 Consciousness and Free Will (also COGST 4310, PSYCH 5310)**

Spring. 4 credits. Limited to 15 students. Prerequisite: PSYCH 2140. Planned M 2-4:25. S. Edelman.

For description, see COGST 4310.

**[BIONB 4340 Advanced Behavioral Ecology**

Spring, 8 weeks. 3 credits. Limited to 20 students. Prerequisites: BIONB 2210, BIOEE 1610 or 1780, permission of instructor. S-U or letter grades. Planned M W F 12:20-2:15. Offered alternate years; next offered 2012-2013. W. D. Koenig.

An intensive course for upper-division students interested in behavioral 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 4350 Mechanisms of Animal Behavior**

Spring. 4 credits. Limited to 30 students. Prerequisites: BIONB 2210. Letter grades only. Planned M W F 2:30-3:20; lab R 2:30-4:25. Offered alternate years; next offered 2012-2013. T. D. Seeley.

Examination of the mechanisms underlying the adaptive behaviors of animals as revealed by whole-organism studies.]

**[BIONB 4440 Neural Computation (also PSYCH 4440)**

Spring. 3 credits. Limited to 10 students. Prerequisites: PSYCH 2230 or BIONB 2220 required or permission of instructor. Recommended: BIONB 3300 or equivalent experience. S-U or letter grades. Planned T R 2:30-3:20, lab T R 3:35-4:25. Offered alternate years; next offered 2011-2012. T. A. Cleland.

For description, see PSYCH 4440.]

**[BIONB 4460 Plant Behavior—Induced Plant Responses to Biotic Stresses, Lectures (also BIOEE 4460)**

Spring. 3 credits. Prerequisite: BIOEE/ BIOG 1610 or permission of instructor. S-U or letter grades. Planned M W F 2:30-3:20. Offered alternate years; next offered 2011-2012. A. Kessler and R. Raguso.

For description, see BIOEE 4460.]

**[BIONB 4461 Plant Behavior—Induced Plant Responses to Biotic Stresses, Laboratory (also BIOEE 4461)]**

Spring. 1 credit. Limited to 12 students. Pre- or corequisite: BIOEE 4460 or BIONB 4460. S-U or letter grades. Planned R 2:30–4:25. Offered alternate years; next offered 2011–2012. A. Kessler and R. Raguso. For description, see BIOEE 4461.]

**[BIONB 4700 Biophysical Methods (also AEP/VETMM 4700)]**

Fall. 3 credits. Prerequisites: solid knowledge of basic physics and mathematics through sophomore level. Recommended: knowledge of cellular biology. Letter grades only. Planned M W 2:45–4:15. Next offered 2011–2012. M. Lindau. For description, see AEP 4700.]

**[BIONB 4910 Principles of Neurophysiology (also BME 4910)]**

Spring. 4 credits. Limited to 20 students. Prerequisite: BIONB 2220 or written permission of instructor. S-U or letter grades for students outside Neurobiology and Behavior concentration and graduate students, by permission of instructor. Planned M W 10:10; lab planned M or T 12:20–4:25. B. R. Johnson.

Laboratory-oriented course designed to teach the theory and techniques of cellular neurophysiology including computer acquisition and analysis of laboratory results. Extracellular and intracellular recording and voltage clamp techniques explore motor neuron and sensory receptor firing properties, and examine the cellular basis for resting and action potentials and synaptic transmission. Lecture time is used to introduce laboratory exercises and discuss results, to supplement laboratory topics, and to discuss primary research papers. Invertebrate preparations are used as model systems. See <http://courses.cit.cornell.edu/bionb491/index.html>.

**[BIONB 4920 Sensory Function (also PSYCH 4920/6920)]**

Spring. 4 credits. Limited to 25 students. Prerequisite: 3000-level course in biopsychology, or BIONB 2220, or BIOAP 3110, or equivalent; knowledge of elementary physics, chemistry, and behavior. S-U or letter grades. Graduate students, see PSYCH 6920. Planned M W F 10:10. Offered alternate years; next offered 2012–2013. B. P. Halpern.

For description, see PSYCH 4920.]

**[BIONB 4930 Developmental Neurobiology]**

Fall. 3 credits. Limited to 20 students. Prerequisite: BIONB 2220 or permission of instructor. S-U or letter grades by permission of instructor. Planned M W 2:55–4:10. Offered alternate years; next offered 2011–2012. R. Booker.

Focuses on both the morphological and molecular basis of neurodevelopment. Assigned readings are taken from original journal and review articles.]

**[BIONB 4950 Molecular and Genetic Approaches to Neuroscience]**

Fall. 3 credits. Limited to 25 students. Prerequisites: junior, senior, or graduate standing; BIONB 2220 and BIOMG 3300 or 3320. Letter grades only. Planned T R 2:55–4:10. Offered alternate years; next offered 2011–2012. D. L. Deitcher.

Focuses on how molecular and genetic approaches have led to major advances in neuroscience. Lectures, student presentations, and discussions examine research articles.]

**[BIONB 4960 Bioacoustic Signals in Animals and Man]**

Fall. 3 credits. Limited to 12 students. Prerequisites: junior, senior, or graduate standing; two majors-level biology courses, PHYS 1101–1102 or 2207–2208, and permission of instructor. S-U or letter grades. Planned M W 9:05; lab R 3–5. Offered alternate years; next offered 2011–2012. C. W. Clark and R. R. Hoy.

Teaches students about animal acoustic signaling by introducing them to various animal acoustic systems.]

**[BIONB 4970 The Brain—Its Evolution and Development]**

Fall. 3 credits. Limited to 50 students. Intended for juniors, seniors, and graduate students. Prerequisite: BIONB 2220 or equivalent. S-U or letter grades. Offered alternate years. Next offered 2012–2013. A. H. Bass.

How does the brain evolve? One of the fastest-growing areas of study in neuroscience is the evolution of developmental mechanisms that have shaped the remarkable diversity in brain organization observed among vertebrates. This lecture course will consider the evolutionary and developmental origins (“evo-devo”) of vertebrate brains from phylogenetic, molecular, anatomical, physiological, and behavioral perspectives. Topics include the evo-devo of brain regions such as the cerebral hemispheres and brainstem; sensory systems ranging from olfaction to vision and hearing; motor systems for posture, locomotion and speech; and mechanisms of social and sexual plasticity.]

**[BIONB 4980 Teaching Experience]**

Fall and spring. 1–4 credits. Limited enrollment. Prerequisites: previous enrollment in course to be taught or equivalent. Note: Arts students may not count this course toward graduation but may, 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 or letter grades by 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.

**[BIONB 6702 Special Topics in Behavioral Ecology (also NTRES 6702)]**

Fall. 1–3 credits (number of credits assigned is based on number of contact hours and reading required to address the topic and material selected each year. All students in a given semester receive same number of credits). Limited to 16 students. Prerequisite: BIONB 2210 or equivalent. Graduate students welcome; undergraduates admitted with special permission of instructors. S-U grades. Day/time: TBA. J. L. Dickinson and W. D. Koenig.

An advanced graduate seminar designed to examine selected topics in behavioral ecology in depth. Topics change each year and address

a critical sub-field or cross-disciplinary area of investigation. Examples of topics include: Evolution of behavioral syndromes (2008), Evolution of empathy and intersubjectivity (2009), and Evolution of social networks in animal societies (2010). Each student is responsible for creating a presentation based on an extensive reading list related to the main topic, and for leading subsequent discussion by the entire group that week. In weeks they are not presenting, students are responsible for a limited subset of the readings and active participation in discussion.

**[BIONB 7000 Introduction to Programming for Research in Neurobiology and Behavior]**

Spring. 4 credits. Limited to 10 students. Prerequisite: permission of instructor. S-U grades only. Planned M,T,W,R,F 9 a.m.–1 p.m. Offered alternate years. C. Linster.

Lab course offering an introduction to programming in Matlab with a focus on neurobiology and behavior. Modeling, data acquisition, signal processing and data analysis.

**[BIONB 7200 Advanced Topics in Neurobiology and Behavior]**

Fall and spring. Variable credit; may be repeated for credit. Prerequisite: graduate standing or permission of instructor. S-U or letter grades. Staff.

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. See department office (W363 Mudd Hall) for offerings.

**[BIONB 7201 Research Design in the Study of Animal Social Behavior]**

Fall and spring. 1 credit; may be repeated for credit. Graduate students only. S-U grades only. Staff.

A weekly journal club-style discussion.

Graduate students may be expected to present a summary of their research or a summary of research in the literature related to their thesis once per year.

**[BIONB 7202 Current Topics in Neuroethology]**

Fall and spring. 1 credit; may be repeated for credit. Graduate students only. S-U grades only. Staff.

A weekly journal club-style discussion.

Graduate students may be expected to present a summary of their research or a summary of research in the literature related to their thesis once per year.

**[BIONB 7203 Research Design in Cellular and Molecular Neurobiology]**

Fall and spring. 1 credit; may be repeated for credit. Graduate students only. S-U grades only. Staff.

A weekly journal club-style discussion.

Graduate students may be expected to present a summary of their research or a summary of research in the literature related to their thesis once per year.

**[BIONB 7210 Introductory Graduate Survey in Neurobiology and Behavior]**

Fall and spring. 2 credits. Requirement for graduate students majoring in neurobiology and behavior. Concurrent registration in BIONB 2210 and 2220

required. S-U grades only. Planned W 4:30-6:00. J. R. Fetcho and staff.

A yearlong, graduate-level seminar with presentations from lecturers in BIONB 2210 and 2220. Discussions of current research in the area of neurobiology or behavior that have been presented in the lecture class. A lab project and/or a writing component each week could be assigned to ensure engagement with the material.

### Related Courses in Other Departments

Evolutionary Perspectives on Behavior (PSYCH 6350)

Biopsychology of Normal and Abnormal Behavior (PSYCH/NS 3610)

Developmental Biopsychology (PSYCH 4220)

Evolution of Human Behavior (PSYCH 3260)

Topics in Biological Anthropology (ANTHR 4390)

Primate Behavior and Ecology (ANTHR 3390)

The Brain and Sleep (PSYCH 4400/6400)

Independent Undergraduate Research in Biology (BIOG 4990)

OTS Undergraduate Semester Abroad Programs

Shoals Marine Laboratory Program

Spider Biology: Life on a Silken Thread (ENTOM 2150)

Navigation, Memory, and Context: What Does the Hippocampus Do? (PSYCH 4230/6230)

## PLANT BIOLOGY (BIOPL)

### BIOPL 1120 Issues in Social Biology: from Diet to Diseases, DNA to Deforestation

Spring or summer, 3-week session. 3 credits. S-U or letter grades. P. J. Davies. An analysis of current issues of biological relevance and the biological science behind these issues. Topics will include issues such as food and nutrition, antioxidants, organic produce, disease prevention, athletic enhancers, genetic testing, cancer, stem cells and animal cloning, genetically modified crops, bacteria and antibiotics, viruses, risk, statistics and epidemiology, photosynthesis and global warming, extinction and overpopulation, invasive species, resource over-utilization. The topics will vary according to current issues.

### BIOPL 1250 Biology Seminar

Fall and spring. 1-2 credits. Prerequisite: none. S-U grades only. Staff. A first-year seminar designed for students with a strong interest in research. Students will interact with faculty while learning to read and evaluate scientific publications on current biological topics. Multiple topics and sections will be offered each semester.

### BIOPL 2210 Natural Remedies in Ethnohealth

Fall. 2 credits. Prerequisites: course work in biology and sociology and health or related area, or permission of instructor. E. Rodriguez.

This course is an introduction to two aspects of ethnomedicine/ethnohealth: (1) the study of biology of health disparities like diabetes, cancer, and infectious diseases in Latinos/as, African Americans and American Indians in the United States, (2) and the botany, culture, and medical anthropology of plants and other natural remedies used by ancient cultures in the Americas and also currently used throughout the United States and the Americas.

### BIOPL 2300 Global Plant Biodiversity and Vegetation

Fall. 3 credits without field trip, 5 credits with field trip. K. Nixon. Plants are distributed across the globe in distinctive vegetation types. Intended for students with minimal or no plant science background. Discusses factors determining vegetation structure, plant diversity, biodiversity hotspots, plant adaptations, human-plant interactions and climate change. An optional field trip to Latin America provides hands-on study of vegetation.

### BIOPL 2400 Green World/Blue Planet (CA)

Fall or summer, 6-week session. 3 credits. S-U or letter grades. Lec. and disc. T. Silva. 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 2410 Introductory Botany and Evolution

Fall. 3 credits. Lec, lab. K. J. Niklas. Introduction to plant diversity, ecology, structure, reproduction, and evolution, with an emphasis on the flowering plants and the history of life on earth. Laboratory and lectures are integrated to provide hands-on skills and concepts. First and second weeks of laboratory are field trips, starting with the first full week of classes.

### BIOPL 2420 Plant Function and Growth Lectures

Spring. 3 credits. Primarily for undergraduates in agricultural sciences but also for any biological sciences students wanting to know about plant function; suitable as second-level course for nonmajors to satisfy biology distribution requirement. Prerequisites: two majors-level biology courses and/or BIOPL 2410. Corequisite for plant science undergraduates (and highly recommended for other science majors): BIOPL 2421. Recommended: one year introductory chemistry. May not be taken for credit after BIOPL 3420 except by written permission of instructor. S-U or letter grades. Evening prelims. 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 2421 Plant Function and Growth, Laboratory

Spring. 2 credits. Limited to 14 students per sec. Corequisite: BIOPL 2420. May not be taken for credit after BIOPL 3440. Disc and lab; students must take lab and disc on same day. T. Silva.

Experiments exemplify concepts covered in BIOPL 2420 and offer experience in a variety of biological and biochemical techniques, from the cellular to whole plant level.

### BIOPL 2430 Taxonomy of Cultivated Plants (also HORT 2430)

Fall. 4 credits. Prerequisite: two majors-level biology courses. May not be taken for credit after BIOPL 2480. Lec, lab. Offered alternate years. M. A. Luckow.

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 2450 Plant Biology

Summer, six-week session. 3 credits. Limited to 24 students. Lec, lab. 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 available for study. Those who lack college-level biology are expected to work closely with the instructor on supplemental instructional materials.

### BIOPL 2470 Plants and People

Spring. 3 credits. Lec, lab. Offered alternate years; next offered 2011-2012. M. A. Luckow.]

### [BIOPL 2480 Vascular Plant Systematics

Spring. 4 credits. Prerequisite: introductory course in biology or botany or permission of instructor. May not be taken for credit after BIOPL 2430. S-U or letter grades. Lec, lab. Offered alternate years; next offered 2011-2012. J. I. Davis.

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 presents an overview of vascular plant diversity, with particular attention to the flowering plants.]

### BIOPL 2490 Hollywood Biology: Science in Cinema

Spring. 3 credits. Lec. Letter grades. M. Scanlon.

Biological subjects presented in Hollywood films. Lecture topics include the scientific method, Darwinism, development, paleobiology, animal cloning, genome sequencing, forensic DNA, artificial intelligence, eugenics, and epidemiology as background to discussions of their presentation in selected films. Themes: Genetics/Genomics; Evolution; Development; Epidemiology; Physical Anthropology; and Genetic Engineering. Does not fulfill any requirement of the biology major.

**BIOPL 3420 Plant Physiology, Lectures**

Spring. 3 credits. Prerequisites: two majors-level biology courses. Corequisite: BIOPL 3421 or written permission of instructor. May not be taken for credit after BIOPL 2420 unless written permission obtained from instructor. Lec. T. G. Owens.

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 3421 Plant Physiology, Laboratory**

Spring. 2 credits. Corequisite: BIOPL 3420. May not be taken for credit after BIOPL 2440. Similar to BIOPL 2440 but at more advanced level. Lab, disc. T. Silva.

Experiments exemplify concepts covered in BIOPL 3420 and offer experience in a variety of biological and biochemical techniques, from the cellular to whole plant level, with emphasis on experimental design.

**BIOPL 3430 Molecular Biology and Genetic Engineering of Plants**

Spring. 2 credits. Prerequisite: one year general biology or permission of instructor. S-U or letter grades. Lec. M. E. Nasrallah.

Introduction to current studies involving recombinant DNA technology and its application to the improvement of plants. Emphasizes genetic transformation methodology, gene expression systems, and strategies for increasing productivity. The course is directed toward undergraduates who wish to become familiar with the theory and practice of plant biotechnology.

**BIOPL 3431 Laboratory in Molecular Biology and Genetic Engineering of Plants**

Spring. 2 credits. Limited to 24 students. Prerequisite: BIOPL 3430 or permission of instructor. Recommended: concurrent enrollment in BIOPL 3430. S-U or letter grades. Lab. M. E. Nasrallah.

Companion to BIOPL 3430 with laboratory activities that focus on the practice of plant biotechnology. Students transfer genes to plants by a variety of methods and analyze their expression in the host genome by use of reporter gene assays and by the preparation and analysis of nucleic acids.

**BIOPL 3450 Plant Anatomy**

Fall. 4 credits. Limited to 15 students. Prerequisite: introductory course in biology or botany or permission of instructor. May not be taken for credit after BIOPL 3470. Lec, lab. Offered alternate years. A. Gandolfo.

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 3470 Anatomy of Plant Model Organisms**

Fall. 3 credits. Prerequisite: introductory course in biology or botany, or permission of instructor. May not be taken for credit after BIOPL 3450. Lec, lab. Offered alternate years; next offered 2011–2012. A. Gandolfo.

The anatomy of plant model organisms is examined. Three main subjects are covered: general plant anatomy, plant structure in phylogenetic framework, and the structure and anatomy of selected plant model organisms (including C3 and C4 grasses and key dicots, including *Arabidopsis* and *Solanum*). Additional taxa will be discussed.]

**[BIOPL 3480 The Healing Forest**

Spring. 2 credits. Prerequisites: one majors-level biology course or plant biology or permission of instructor. Lec/disc. Offered alternate years. Staff.]

**BIOPL 3590 Biology of Grasses**

Spring. 2 credits. Prerequisite: two majors-level biology courses or course in plant systematics or permission of instructor. S-U or letter grades. Lec. Lab. 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 3800 Strategies and Methods in Drug Discovery**

Spring. 2 credits. Prerequisite: two majors-level biology courses and organic chemistry course or permission of instructor. S-U or letter grades. M. A. Aregullin.

Covers strategies and methodologies in chemotaxonomy, chemical ecology, and ethnobotany, as they are used in chemical prospecting for new pharmaceuticals. Discusses the biosynthesis and distribution of plant secondary metabolites, the use of techniques in isolation and structure elucidation of natural products, and biological assays in the discovery of chemicals with pharmacological activity.

**[BIOPL 4010 Introduction to Scanning Electron Microscopy]****[BIOPL 4030 Transmission Electron Microscopy for Biologists]****BIOPL 4220 Plant Development**

Fall. 2 credits. Lec. Prerequisites: course work in molecular biology (e.g., BIOMG 3300, 3310/3320, or 3330), and genetics (e.g., BIOMG 2810), or permission of instructor. S-U or letter grades. J. Hua.

Introduction to plant development, studying the mechanisms of morphogenesis and cell fate determination at the organismal, cellular, and molecular levels.

**BIOPL 4400 Phylogenetic Systematics (also ENTOM 4400)**

Spring. 4 credits. Limited to 24 students. Prerequisite: one majors-level biology course or permission of instructor. Lec, lab. Offered alternate years. K. C. Nixon.

Basic and advanced theory and methods of phylogenetic analysis. Introduces students to

cladistic analysis using parsimony and gain experience with computer-aided analysis of taxonomic data, including both morphological and molecular data sources. Topics include applications of phylogenetic methods to biogeography and evolutionary studies.

**[BIOPL 4420 Current Topics in Ethnobiology**

Fall. 2 credits. Limited to 12 students. Prerequisite: permission of instructor. S-U or letter grades. Lec/disc. Offered alternate years. Staff.]

**BIOPL 4430 Topics and Research Methods in Systematics**

Fall or spring. 1–2 credits; 1 credit per sec. Prerequisite: written permission of instructor. S-U or letter grades. K. C. Nixon.

Series of 1-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 4440 Plant Cell Biology**

Fall. 4 credits. Limited to 24 students. Prerequisites: two majors-level biology courses or permission of instructor. Lec, lab. R. O. Wayne.

Uses evidence from microscopy, physiology, biochemistry, and molecular biology to try to unravel the mystery of the living cell. Studies the dynamics of protoplasm, membranes, and the various organelles. 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 4450 History of Systematic Botany**

Fall. 3 credits. S-U or letter grades. Lec. Offered alternate years; next offered 2011–2012. J. Reveal.

An historical overview from early man to the present day of systematic botany concentrating on nomenclature and classification with an emphasis of botanical explorations and their impact on plant taxonomy.]

**[BIOPL 4470 Molecular Systematics**

Fall. 3 credits. Prerequisites: BIOEE 1780 or BIOMG 2810 or BIOMG 3300, or BIOMG 3320, or written permission of instructor. Lec. Offered alternate years; next offered 2011–2012. J. J. Doyle.

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 4480 Plant Evolution and the Fossil Record**

Spring. 3 credits. Prerequisite: BIOPL 2410 or equivalent, or permission of instructor. Lec, lab. Offered alternate years. K. J. Niklas and W. L. Crepet.

Introduction to evolution, surveying major changes in plants from the origin of life to the present. Emphasizes plant form and function, adaptations to particular ecologic settings, and evolutionary theory as it relates to plants.

**BIOPL 4500 Light and Video Microscopy for Biologists**

Fall. 3 credits. Limited to 12 students.

Prerequisites: two majors-level biology courses and permission of instructor. Lec, lab. R. O. Wayne.

Students learn the relationship between reality and the image using philosophy, mathematics, and physical theory. Next they apply these tools theoretically and in practice to understand and become experts at image formation and analysis using brightfield, darkfield, phase-contrast, fluorescence, polarization, interference, differential interference, and modulation contrast microscopes. They build upon our knowledge and experience to understand how analog image processors and digital image processors can influence, enhance, and analyze the images gathered by the microscope. Last they learn about many other kinds of microscopes, including confocal, near field, x-ray, acoustic, nuclear magnetic resonance, infrared, centrifuge, atomic force, and scanning tunneling microscopes.

**[BIOPL 4520 Systematics of Tropical Plants**

Fall. 3 credits. Prerequisite: BIOPL 2430 or 2480. Letter grades only. Lec, lab. Offered every three years. 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 4521 Systematics of Tropical Plants: Field Laboratory**

Spring. 1 credit. Limited to 15 students. Prerequisite: BIOPL 4520 or permission of instructor. Letter grades only. For more details and application, contact L. H. Bailey Hortorium, 412 Mann Library. Offered every three years. K. C. Nixon.

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. Two-week field trip over winter break.]

**BIOPL 4620 Plant Biochemistry**

Spring. 3 credits. Prerequisites: BIOPL 2420 or 3420 or equivalent and BIOMG 3300 or 3310 or equivalent or permission of instructor. Letter grades only. Lec. J. Rose and K. Van Wijk.

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 4821-4822 Molecular Plant-Pathogen Interactions I and II (also PLPA 4821-4822)**

Spring, 12 lec. 1 credit. Prerequisites: BIOMG 2810, BIOMG 3300 or 3310, and BIOPL 4831. A. R. Collmer and B. G. Turgeon (odd years); S. G. Lazarowitz and G. B. Martin (even years).

Examines the molecular and cellular factors that control pathogen-plant interactions from the perspectives of pathogen biology and

plant responses to pathogen infection. Alternate years will focus on (1) plant perception of microbial pathogens and the interplay of plant defenses and pathogen counterstrategies that result in resistance or susceptibility to disease production, with topics including the genetic nature of dominant and recessive resistance, induction of pathogen defense genes, apoptotic responses that limit infection and RNA interference; and (2) the genetic and molecular mechanisms of microbial pathogenesis, with an emphasis on fungal and bacterial virulence proteins, toxin and their deployment systems.

**[BIOPL 4823 Molecular Plant-Microbe Interactions (also BIOMI/PLPA 4823)**

Spring. 1 credit. Prerequisites: BIOMG 2810 and BIOMG 3300 or 3320, or equivalents. Recommended: BIOMG 3310. S-U or letter grades. 12 lec. Offered alternate years; next offered 2011-2012. S. C. Winans.

Focuses on the interactions of *Agrobacterium* and *Rhizobium* 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.]

**BIOPL 4824 Plant Gene Evolution and Phylogeny**

Spring. 1 credit. 12 lec. Prerequisites: BIOMG 2810 and BIOMG 3300 or 3320, or equivalents. Recommended: BIOMG 3310. 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.

**BIOPL 4825 Molecular Biology of Plant Organelles (also BIOMG 4825)**

Spring. 1 credit. 12 lec. Prerequisites: BIOPL 4831 or BIOMG 2810 and permission of instructor. Recommended: BIOMG 3310 or equivalent. Letter grades or S-U grades with permission of instructor. Offered alternate years. M. R. Hanson and D. B. Stern.

Plants contain three different genomes—in the nucleus, chloroplasts, and mitochondria. This course examines the organization, expression, and evolution of plant organelle genomes. Special topics include RNA editing and stability, effects of organelle mutations on plant reproduction and photosynthesis, and chloroplast transformation for expression of useful foreign proteins.

**BIOPL 4826 Plant Biotechnology (also PLBR 4826)**

Spring. 1 credit. 12 lec. Prerequisites: BIOPL 4831 or permission of instructor. S-U or letter grades. E. D. Earle.

Deals with production and uses of transgenic plants for agricultural and industrial purposes.

Topics include procedures for gene introduction and control of gene expression, as well as strategies for obtaining transgenic plants that are resistant to insects, diseases, and herbicides, produce useful products, or have improved nutritional and food processing characteristics. Regulatory and social issues relating to plant biotechnology are discussed.

**[BIOPL 4829 Light Signal Transduction in Plants**

Spring. 1 credit. 12 lec. Prerequisites: BIOMG 2810 and BIOMG 3300 or 3320, or equivalents. Recommended: BIOMG 3310. S-U or letter grades. Offered alternate years; next offered 2011-2012. T. Brunnell.

In addition to providing plants with energy for photosynthesis, light plays an essential role in the development of higher plants. Light quality and intensity is carefully monitored by the plant to avoid neighboring vegetation, set the circadian clock, and adjust photosynthesis rates. This course focuses on recent studies that have illuminated the molecular basis of light signal transduction networks in higher plants. Readings are assigned from current literature with an emphasis on those that use genomics tools such as microarray analysis to address fundamental questions in red/far-red and blue light signal transduction.]

**BIOPL 4831 Concepts and Techniques in Plant Molecular Biology (also PLPA/BIOMG/PLBR 4831)**

Fall. 3 credits. Prerequisites: BIOMG 2810 and BIOMG 3300 or 3320, or equivalents. Recommended: BIOMG 3310. Lec. S-U or letter grades. M. Scanlon, M. Hanson, and T. Owens.

Introductory module that provides a broad overview of molecular biology concepts relevant to the plant sciences. Serves as a prerequisite to other modules in the BIOPL 483X (fall) and BIOPL 482X (spring) classes. Course covers genetic concepts relevant to molecular markers, map-based cloning, insertional mutagenesis, forward and reverse mutant screens, analysis of transcriptomes, organelle and nuclear genome structure, and transformation. Techniques include nucleic acid manipulation, blot and in situ hybridization, chromatin immunoprecipitation, high throughput sequencing, PCR, microscopy, laser microdissection, microarrays, metabolomic profiling, proteomics, protein-protein interactions, electrophoresis, and immunological methods.

**[BIOPL 4832 Proteomics and Protein Mass Spectrometry in Biology (also PLPA/PLBR 4832)**

Fall. 1 credit. 12 lec. Prerequisites: BIOMG 2810 and BIOMG 3300 or 3320, or equivalents. Recommended: BIOMG 3310. S-U or letter grades. Offered alternate years; next offered 2011-2012. K. van Wijk.

Introduction to proteomics and mass spectrometry and its application in plant biology. Includes discussion of protein separation, protein tagging and visualization techniques; principles of biological mass spectrometry and interpretation of spectra; bioinformatics tools in proteomics; comparative proteomics; phosphorylation mapping. Discusses limitations and possibilities of proteomics on plants for which little sequence information is available and experimental papers involving plant proteomics.]

**BIOPL 4834 Molecular Aspects of Plant Development I (also BIOMG 4834)**

Fall 1 credit. 12 lec. Prerequisites: BIOMG 2810 and BIOMG 3300 or 3320, or equivalents. Recommended: BIOMG 3310. Offered alternate years. J. B. Nasrallah.

Focuses on the molecular genetics of plant development with an emphasis on plant reproductive biology. 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 functional differentiation of specialized cell types, and the control of developmental pathways by endogenous and external cues. It is a companion to BIOPL 4823 (Molecular Plant-Microbe Interactions).

**BIOPL 4836 Plant Senescence (also HORT 6252)**

Fall. 1 credit. 12 lec. Prerequisites: BIOMG 2810 and BIOMG 3300 or 3320, or equivalents. Recommended: BIOMG 3310. S-U or letter grades. (12 lec). Offered alternate years. S. Gan.

Introduces molecular, genetics, and genomics approaches in plant senescence and postharvest research. Topics include gene expression, regulation, and function associated with physiological and biochemical changes in senescing, maturing, and/or ripening plants or parts. Genetic manipulation of senescence/ripening processes are also discussed.

**BIOPL 4980 Teaching Experience**

Fall or spring. 1-4 credits. Limited enrollment. Prerequisites: previous enrollment in course to be taught or equivalent. Note: Arts students may not count this course toward graduation but may, 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 or letter grades by permission of the 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.

**BIOPL 6410 Laboratory in Plant Molecular Biology (also BIOMG 6410)**

Fall. 4 credits. Prerequisites: BIOMG 2810 or equivalent, BIOMG 3300 or 3310 or equivalent, and permission of instructor. S-U grades by permission of instructor. Lab. J. Nasrallah, M. R. Hanson, H. Wang, T. Brutnell, G. Jander, S. Popescu, J.-Y. Lee, M. Scanlon, and K. van Wijk.

Includes selected experiments on gene expression, biolistic transformation, confocal microscopy, laser capture microdissection, microarray analysis, genetic mapping and mutant analysis, transposon tagging, proteomics, and metabolite analysis.

**BIOPL 6420 Mineral Nutrition: From Plants to Humans (also CSS 6420)**

Spring. 3 credits. Prerequisite: BIOPL 3420 or equivalent. Lec. Offered alternate years. O. K. Vatamaniuk, L. V. Kochian, and R. M. Welch.

For description, see CSS 6420.

**BIOPL 6470 Systematic Biology Journal Club**

Fall or spring. 1 credit; may be repeated for credit. Intended for graduate students and advanced undergraduates in systematic biology. S-U grades only. Disc TBA. Bailey Hortorium staff.

Discussions led by staff, visitors, and students on topics of current importance to systematic biology.

**BIOPL 6490 Solute Transport in Plants (also BEE 6490)**

Fall. 3 credits. Letter grades only. Lec. Offered alternate years. R. M. Spanswick. For description, see BEE 6490.

**[BIOPL 6510 Water Transport in Plants (also BEE 6470)]**

Fall. 2 credits. Letter grades only. Lec. Offered alternate years; next offered 2011-2012. R. M. Spanswick.

For description, see BEE 6470.]

**BIOPL 6540 Botanical Nomenclature**

Fall. 3 credits. Prerequisite: written permission of instructor. S-U or letter grades. Lec and disc. Offered alternate years. J. Reveal.

Analysis of the International Code of Botanical Nomenclature and its application to various plant groups.

**BIOPL 6560 Topics in Plant Evolution**

Spring. 1 credit. Prerequisite: BIOPL 4480 or equivalent background in evolution, or written permission of instructor. Lab and disc. Offered alternate years. K. J. Niklas.

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 7400 Plant Biology Seminar**

Fall and spring. 0 credits. Requirement for graduate students doing work in plant biology. W. L. Crepet.

Lectures on current research in plant biology, presented by visitors and staff.

**BIOPL 7410 Problems in Plant Cell and Molecular Biology**

Spring. 2 credits. Prerequisite: first- and second-year graduate students in Plant Cell and Molecular Biology Program. Disc.

Introduction to the research literature in plant molecular and cellular biology through weekly problem sets and discussions.

**BIOPL 7420 Current Papers in Plant Biology**

Fall or spring. 1 credit. Limited enrollment. Primarily for graduate students, with priority given to majors or minors in plant molecular biology. Prerequisite: for undergraduates, written permission of instructor. S-U grades only. Sem. Staff.

**BIOPL 7430 Faculty Research in Plant Cell and Molecular Biology**

Fall. 1 credit. Prerequisite: graduate standing or written permission from member of Plant Cell and Molecular Biology Program or from coordinator for undergraduates. Disc TBA. Staff.

Introduction for graduate students to the research being conducted by Cornell faculty in the Plant Cell and Molecular Biology Program.

**BIOPL 7440 Graduate Research in Plant Biology**

Fall or spring. 1 credit. Requirement for, and limited to, all graduate students in the Field of Plant Biology. Sem. Staff.

After the first year, each student presents one seminar per year on his or her thesis research and then meets with the thesis committee members for evaluation. First-year students only attend the seminar series, they do not present. Second-year students give a 25-min. seminar, while students in their third and higher years present a 50-min. seminar.

**BIOPL 7450 Seminar in Systematic Botany**

Fall. 1 credit. Prerequisite: graduate standing or permission of instructor. S-U grades only. Sem. Bailey Hortorium staff.

Seminar with student presentations of current topics in systematics.

**BIOPL 7460 Seminar in Systematic Botany: Student Research**

Spring. 1 credit. Prerequisite: graduate standing or permission of instructor. Letter grades only. Sem. Bailey Hortorium staff.

Student-led seminar presentation based on his or her thesis research or a related topic.

**BIOPL 7490 Graduate Research in Botany**

Fall or spring. Variable credit; may be repeated for credit. S-U or letter grades. Staff.

Similar to BIOG 4990 but intended for graduate students who are working with faculty members on an individual basis.

**Related Courses in Other Departments**

Current Topics in Plant Molecular Ecology (BIOEE 6750)

Fungal Biology (PLPA 6490)

Fungi (PLPA 3090)

Marine Botany (BIOSM 4490)

Physiological Plant Ecology, Lectures and Laboratory (BIOEE 4660/4661)

Plant Behavior-Induced Plant Responses to Biotic Stresses (BIOEE 4460)

Plant Cytogenetics Laboratory (PLBR 4460)

Undergraduate Research in Biology (BIOG 4990)

**COURSES IN MARINE SCIENCE**

Cornell offers many undergraduate courses in marine science. Undergraduates are encouraged to consider: (1) undergraduate specialization in Marine Biology (through Ecology and Evolutionary Biology); (2) undergraduate specialization in Ocean Sciences (through the Science of Earth Systems Program); and (3) other summer courses offered by the Shoals Marine Laboratory (SML), Cornell's field station on Appledore Island, Maine. For the most current information on all three of these options, visit SML online at: [www.sml.cornell.edu](http://www.sml.cornell.edu).

1. Undergraduate Specialization in Marine Biology (through Ecology and Evolutionary Biology)

Biological Sciences majors in the ecology and evolutionary biology program of study can specialize in marine biology; this allows a focus on the biology of marine organisms. In addition to fulfilling major requirements and requirements for the ecology and evolutionary biology program of study, students specializing in marine biology should enroll in one or more of the following courses:

**BIOEE Courses:**

BIOEE 2740 The Vertebrates: Structure, Function, and Evolution

BIOEE 4750 Ornithology

BIOEE 4760 Biology of Fishes

BIOEE 3500 Dynamics of Marine Ecosystems (also EAS 3500)

BIOEE 3510 Conservation Oceanography (also EAS 3510)

BIOEE 3730 Biodiversity and Biology of the Marine Invertebrates

BIOEE 4620 Marine Ecology (also EAS 4620)

**BIOSM Courses:** See BIOSM courses that are 3000 or 4000 level. Contact SML with questions: 607 255-3717 or shoals-lab@cornell.edu

2. Undergraduate Specialization in Ocean Sciences (through the Science of Earth Systems Program)

Science of Earth Systems majors can specialize in ocean sciences to study interactions of biological, chemical, geological, and physical processes in the ocean. Students specializing in ocean sciences are required to take four courses from the following list:

**BIOSM and SEA Courses:**

BIOSM 3080 Field Microbial Ecology

BIOSM 3090 Coastal Ecology and Bioclimates

BIOSM 3640 Field Marine Science (FMS)

BIOSM 3650 Underwater Research

SEA 3660 SEA Introduction to Oceanography

SEA 3670 SEA Introduction to Maritime Studies

SEA 3680 SEA Introduction to Nautical Science

SEA 3690 SEA Practical Oceanography I

SEA 3700 SEA Practical Oceanography II

SEA 3720 SEA Practical Oceanography III

BIOSM 3750 Field Marine Biology and Ecology

SEA 3780 SEA Oceans and Climate: Oceans in the Global Carbon Cycle

SEA 3790 SEA Ocean Science and Public Policy

SEA 3800 SEA Oceanographic Field Methods

SEA 3810 SEA Independent Research in Oceans and Climate

SEA courses must be taken concurrently. This program is run by SEA Education Association (SEA) in Woods Hole, Mass. Contact SEA at 800 552-3633 and see [www.sea.edu](http://www.sea.edu).

Can use one of the following organismal courses:

BIOSM 3760 Biology of the Marine Invertebrates

BIOSM 3770 Diversity of Fishes

BIOSM 4490 Marine Botany

BIOSM 4770 Marine Vertebrates

**EAS Courses:**

EAS 3220 Biogeochemistry of the Hawaiian Islands

EAS 3400 Field Study of the Earth System

EAS 3420 Atmospheric Dynamics

EAS 3500 Dynamics of Marine Ecosystems (also BIOEE 3500)

EAS 3510 Conservation Oceanography

EAS 3530 Physical Oceanography

EAS 4060 Marine Geology and Geophysics

EAS 4620 Marine Ecology (also BIOEE 4620)

EAS 5050 Fluid Dynamics in the Earth Sciences

EAS 7500 Satellite Remote Sensing in Biological Oceanography

**BIOEE Courses:**

BIOEE 3730 Biodiversity and Biology of the Marine Invertebrates

BIOEE 4570 Limnology: Ecology of Lakes, Lectures

BIOEE 4571 Limnology: Ecology of Lakes, Laboratory

BIOEE 4780 Ecosystem Biology

BIOEE 6680 Principles of Biogeochemistry

**SHOALS MARINE LABORATORY (BIOSM)**

G14 Stimson Hall, 255-3717

Shoals Marine Laboratory (SML) provides a unique opportunity to explore marine sciences on Appledore Island, Maine, an island noted for its biota, geology, and history. SML has established a national reputation for excellence and is North America's largest marine field station focusing on undergraduate education.

The summer population of Appledore Island is limited to one hundred people at any one time. Students and faculty 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 in marine sciences 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 or 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 integral to all courses, using Appledore's extensive intertidal and subtidal zones and seabird colonies. Faculty, drawn from Cornell University, the University of New Hampshire, and other leading academic institutions, are selected based not only on their academic excellence but also on their ability to teach in the field. Many guest lecturers including engineers, coastal planners, and specialists from private

industry, government, as well as the academic community visit Appledore during the season. The SML main administrative office is located at Cornell's Ithaca campus, G14 Stimson Hall. The office serves as an advising center for students interested in the marine sciences, maintains updated information on graduate study and career opportunities as well as on marine programs at other institutions.

The following marine sciences courses are currently administered by the Shoals Marine Lab. (Not all of these courses are offered each semester; consult the SML web site for current offerings: [www.sml.cornell.edu](http://www.sml.cornell.edu).)

**BIOSM 1110 A Marine Approach to Introductory Biology**

Summer. 8 credits. Prerequisite: permission of instructor. Letter grades only. A four-week course for pre-freshmen at Shoals Marine Lab (SML) on Appledore Island in the Gulf of Maine. W. E. Bemis, J. B. Heiser, and D. Taylor.

Course includes daily fieldwork, boat trips, outdoor adventure, and practices for sustainable living. Intensive lectures, laboratory, and fieldwork occur in a learning environment emphasizing individual skill building, project design and execution, and collaboration with faculty and peers. We explore four major themes—ecology, behavior, development, and genomics—and connect them using examples from evolution. Social issues discussed range from global environmental change to sustainable fisheries, emerging infectious diseases, and stem cell research.

**[BIOSM 1230 Ocean Sciences**

Summer. 4 credits. Prerequisite: permission of instructor. Letter grades only. Next offered 2011-2012. D. Taylor.]

**BIOSM 1551 Introduction to Oceanography (also EAS 1551)**

Summer. 1 credit. Prerequisite: college-level science course, EAS 1540, marine science course, or permission of instructor (any of these). S-U or letter grades. B. Monger and C. Greene.

For description, see EAS 1551.

**BIOSM 1600 The Oceanography of the Gulf of Maine**

Summer. 2 credits. Limited to 24 students. Prerequisite: high school juniors and seniors who have successfully completed two high school science courses. S-U or letter grades. A two-week course offered aboard a SEA vessel and at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. For more details or an application, contact SML office, G14 Stimson Hall or website ([www.sml.cornell.edu](http://www.sml.cornell.edu)) or Sea Education Association office, P.O. Box 6, Woods Hole, MA 02543, 800-552-3633 X 770 or web site: [www.sea.edu](http://www.sea.edu). Daily lec, lab, and fieldwork for two weeks. S. Rensselaer, and SEA and SML staff.

Exciting opportunity to explore the offshore and near-coastal environments of the Gulf of Maine for advanced high school students. 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 1610 Introduction to Marine Science**

Summer. 4 credits. S–U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for two weeks. Next offered 2011–2012.]

**BIOSM 1620 Marine Environmental Science**

Summer. 4 credits. Prerequisite: open to high school rising junior and senior students who have successfully completed two high school science courses. S–U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for 14 days. M. Johnson.

Environmental studies have become an integral component of high school programs all around the country; however, opportunities to apply this course work to the marine environment are limited. Marine Environmental Science focuses on coastal marine habitats, with an emphasis on issues as they relate to global habitats and concerns. Laboratory exercises and fieldwork include explorations along Appledore Island's rocky intertidal zone and excursions to neighboring islands to observe harbor seal and seabird colonies. Offshore cruises include oceanographic sampling exercises and field trips to seabird and whale foraging grounds. Lectures and discussions expose MES students to topics ranging from fishes to fisheries, seaweeds to lobsters, and plankton to whales. Fundamental scientific research methods and equipment are introduced, and each student has the opportunity to be involved in group research projects.

**BIOSM 2040 Biological Illustration**

Summer. 2 credits. Prerequisite: none. S–U or letter grades. A one-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. B. Ober, C. Garrison, and J. Gibson.

General discussion of scientific publishing, illustration labeling, color techniques, and printing processes. 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 2100 Boats for Biologists**

Summer. 2 credits. Prerequisite: open to all undergraduate and graduate students. S–U or letter grades. A one-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. W. E. Bemis.

Marine and freshwater biologists rely on boats—small and large—for transportation, environmental sampling, data collection, and other tasks. This course offers biologists at all stages of their careers a chance to learn basic boat handling, piloting, navigation, and common sampling techniques to enhance their opportunities for research and education. This course meets all certification requirements for basic small boat handling by state-specific agencies and National Association of Boating Law Administrators.

**[BIOSM 2250 Sustainability in the 21st Century**

Summer. 4 credits. Prerequisite: open to all undergraduate and graduate students. Letter grades only. A two-week course offered at Shoals Marine Laboratory (SML) on Appledore Island in the Gulf of Maine. Next offered 2011–2012. Cornell, UNH, SML faculty and staff.]

**[BIOSM 2760 Seabird Ecology and Conservation**

Summer. 2 credits. Prerequisite: two semesters college-level biology or equivalent. S–U or letter grades. A one-week course offered at Shoals Marine Laboratory (SML) on Appledore Island in the Gulf of Maine. Next offered 2011–2012. J. Ellis.]

**BIOSM 2770 Introduction to Marine Conservation Biology**

Summer. 4 credits. Prerequisite: two semesters college-level biology or equivalent. S–U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. H. Weeks and K. Flessa.

Students will study introduction to the examination and analysis of marine biological resource conservation and management issues. Class will address principles and problems through readings, laboratory modeling exercises and lectures, including guests from the New England region, and explore potential pathways to success through readings and field trip.

**BIOSM 3060 Evolution of Ancient and Modern Oceans (also EAS 3060)**

Summer. 6 credits (students will have the opportunity to continue their studies during the fall semester on campus at Cornell for another 2 credits of independent study). Prerequisite: one semester oceanography and /or marine biology or permission of instructor. Letter grades only. W. Allmon.

For description, see EAS 3060.

**BIOSM 3080 Field Microbial Ecology (also BIOMI 3080)**

Summer. 4 credits. Prerequisite: two semesters college-level biology or equivalent. S–U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. E. Zettler and L. A. Zettler.

The microbial world dominates the biosphere in terms of biomass, diversity, and metabolic flexibility. This course will introduce students to collecting, observing, and identifying live representatives of these fascinating microbial organisms including bacteria, protists, fungi, and microscopic animals. Taxonomy and ecology of the basic groups of microorganisms will be covered while students learn to collect in the field for observation, experimentation and isolation.

**[BIOSM 3090 Coastal Ecology and Bioclimates**

Summer. 4 credits. Prerequisite: two semesters college-level biology or equivalent; background preferred in physics/physical geography. S–U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. For more details or an application, contact SML office, G14 Stimson Hall. Daily lec, lab, and fieldwork for two weeks. Next offered 2011–2012. G. Courtin.]

**[BIOSM 3100 Marine Symbiosis**

Summer. 4 credits. Prerequisite: two semesters college-level biology or equivalent. Recommended: background in microbiology or cell biology. S–U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec and fieldwork for two weeks. Next offered 2011–2012. SML faculty.]

**BIOSM 3110 Science Writing**

Summer. 2 credits. Prerequisite: introductory-level science course. One-week course offering students an introduction to science writing at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. S–U or letter grades. C. Zimmer.

Students will learn about the business of science writing (including career opportunities in newspapers, television, and the Internet). They will also have the opportunity to become familiar with the craft of making complex scientific research understandable and exciting for the general public. Students should be prepared to complete several short-deadline writing exercises.

**BIOSM 3120 Biology of the Lobster**

Summer. 2 credits. Prerequisite: two semesters college-level biology or equivalent. S–U or letter grades. A one-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. J. Factor.

An introduction to the biology of the American lobster, *Homarus americanus*. The course will include an overview of this ecologically and economically important species, as well as cover several major topics in depth, each taught by a lobster biologist expert in that field. Topics may include life history, larval development and metamorphosis, anatomy, physiological adaptation, fisheries and fishing methods, feeding mechanisms, ecology, and behavior. Course will include lecture, laboratory, discussion, and the natural field environment of Appledore Island.

**[BIOSM 3200 Functional Morphology of Marine Organisms**

Summer. 4 credits. Prerequisite: two semesters college-level biology or equivalent. Letter grades only. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Next offered 2011–2012. F. Fish.]

**BIOSM 3210 Anatomy and Function of Marine Vertebrates**

Summer. 4 credits. Prerequisite: two semesters college-level biology or equivalent. S–U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. W. E. Bemis, EE&B faculty, and F. Fish.

Course includes introductions to vertebrate systematics, paleontology and evolution, vertebrate development, and functional morphology. Students will do comparative study of the anatomy of marine vertebrates, including: hagfishes; lampreys; sharks, skates, rays and chimaeras; ray finned fishes; lobe-finned fishes; marine reptiles, birds, and mammals. All 10 organ systems of vertebrates will be detailed in lecture and laboratory exercises. Dissection is required. Grades will be based on quizzes, essay exams, practical exams, class participation, and research projects.

**[BIOSM 3220 Ecology of Biological Invasions]**

Summer. 4 credits. Prerequisite: two semesters college-level biology or equivalent. One-week field course examining marine and terrestrial invasions in the field using facilities at Shoals Marine Laboratory (SML) on Appledore Island in the Gulf of Maine and at Creek Farm in Portsmouth, N.H. S-U or letter grades. Next offered 2011-2012. R. Hadlock Seeley and J. Dijkstra.

The course includes both a thorough review of theory of invasions (and their ecological and evolutionary sequelae) and field time with invited experts in invasive insect, plant, marine invertebrate and bird species.]

**[BIOSM 3290 Ecology of Animal Behavior (also BIONB 3290)]**

Summer. 4 credits. Prerequisite: two semesters college-level biology or equivalent. Recommended: course work in ecology, psychology, or behavior. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for two weeks. H. Weeks, J. Waldvogel, and W. Kimler.

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 3640 Field Marine Science (FMS)]**

Summer. 8 credits. Prerequisite: two semesters college-level biology or equivalent. S-U or letter grades. A four-week course offered twice each summer at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Students may not take FMS after taking FMBE (BIOSM 3750). Daily lec, lab, and fieldwork for four weeks. Three core faculty members assisted by up to 15 visiting lecturers, including representatives of governmental agencies. J. Factor, R. Zechman, S. Morris, W. E. Bemis, and E. Zettler.

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 3750) places an additional emphasis on ecology, especially in the intertidal zone; ecological, evolutionary and physiological adaptations of marine organisms; and field experiments.

**[BIOSM 3650 Underwater Research]**

Summer. 4 credits. Prerequisites: two semesters college-level biology or equivalent, recognized SCUBA certification, and medical exam. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec and fieldwork for two weeks. J. Coyer, J. Grabowski, and E. Calvert.

Covers the philosophy of research, hypothesis testing and experimental design, sampling methods, various underwater techniques, diving physics and physiology, and use of dive tables. Emphasizes subtidal ecological research. Requirements include critical evaluation of several journal articles and production of a research proposal.

**[BIOEE 3730 Biology and Biodiversity of the Marine Invertebrates]**

Fall (but course must be taken previous summer at Shoals Marine Laboratory [SML]), three-week, full-time course. 5 credits (students enroll for credit during fall semester). Limited to 24 students. Prerequisites: two semesters college-level biology or equivalent; permission of faculty because off campus. Letter grades only. Daily and evening lec, lab, and fieldwork. Offered alternate years. C. D. Harvell.

**[BIOSM 3740 Field Ornithology]**

Summer. 4 credits. Prerequisite: two semesters college-level biology or equivalent. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec and fieldwork for two weeks. D. Bonter.

Introduction to field ornithology focusing on the biology, ecology, and behavior of the avifauna on the Isles of Shoals. Focuses on fieldwork 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 3750 Field Marine Biology and Ecology (FMBE)]**

Summer. 8 credits. Prerequisites: two semesters college-level biology or equivalent. S-U or letter grades. A four-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for four weeks. K. A. Miller and C. Siddon.

Designed for students seeking an introduction to the marine sciences and marine ecology; FMBE emphasizes fieldwork 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 3640).

**[BIOSM 3760 Marine Invertebrate Zoology]**

Summer. 6 credits. Prerequisite: two semesters college-level biology or equivalent and permission of instructors. Students may not take BIOSM 3760 after taking BIOEE 3730. S-U or letter grades. A three-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for three weeks. Offered alternate years; next offered 2011-2012. J. Morin.]

**[BIOSM 3770 Diversity of Fishes]**

Summer. 6 credits. Prerequisite: two semesters college-level biology or equivalent. Recommended: background in vertebrate biology. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lecs and fieldwork for two weeks.

B. Collette.

Intensive lecture, laboratory, and field course. Lectures cover the basic anatomy and physiology of fishes with examples drawn from a wide variety of fishes from throughout the world. The course emphasizes the diversity of fishes in two aspects, diversity of evolutionary solutions to problems faced by fishes and the great diversity of different types of fishes that inhabit the world. Laboratory exercises cover the anatomy and osteology of teleost fishes and identification of local species. Each student selects a different local species of teleost fish to study and dissect and prepares a comprehensive paper on its morphology, soft anatomy, and osteology.

**[BIOSM 3820 Comparative Embryology and Life History Strategies]**

Summer. 2 credits. Prerequisite: two semesters college-level biology or equivalent. S-U or letter grades. A one-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Next offered 2011-2012. W. E. Bemis, EE&B faculty.]

**[BIOSM 4100 Animal Social Behavior]**

Summer. 2 credits. Prerequisite: introductory biology. Letter grades only. A one-week course offered at Shoals Marine Laboratory (SML) on Appledore Island in the Gulf of Maine. Next offered 2011-2012. T. Seeley, P. Sherman, and J. Shellman Sherman.]

**[BIOSM 4130 Research in Marine Biology]**

Summer. 4 credits. Prerequisite: two semesters college-level biology or equivalent. Recommended: experience in ecology or physiology. S-U or letter grades. A three-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for two weeks. Next offered 2011-2012. D. Taylor, D. Fudge, A. Todgham, and J. Lim.]

**[BIOSM 4450 Forensic Science for Wildlife Biologists (also VTMED 6435)]**

Summer. 2 credits. Prerequisite: two semesters college-level biology or equivalent. S-U or letter grades. A one-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. W. Lord, R. Haebler, R. Kenney, W. Rodriguez, and I. Sidor.

Forensic science represents the unique merging of scientific insight and the law. Forensic Science for Marine Biologists provides a field-oriented introduction to the forensic science domain and the utilization of marine biology within the justice system. Students receive comprehensive instruction concerning the recognition, documentation, collection, and preservation of physical evidence. Additionally, students develop practical incident response, scene management, and forensic teamwork skills.

**[BIOSM 4490 Marine Botany**

Summer. 4 credits. Prerequisite: two semesters college-level biology or equivalent. S-U or letter grades. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for two weeks. Next offered 2011–2012. R. Zechman.]

**BIOSM 4650 Sharks: The Biology, Evolution, and Conservation of Sharks and Their Allies**

Summer. 3 credits. Prerequisite: vertebrates or comparative anatomy and ichthyology or permission of SML director. S-U or letter grades. A one-and-a-half-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. D. Dagit and W. E. Bemis.

The last 30 years have produced an explosion of new information on the biology of the approximately 1,000 living species of sharks, skates, rays, and chimaeras, which collectively make up the group Chondrichthyes. This course will cover advanced topics in the evolution, diversity, anatomy, functional morphology, neurobiology, sensory systems, behavior, reproduction, development, and conservation of cartilaginous fishes.

**BIOSM 4720 Genetics of Marine Diversity**

Summer. 4 credits. Prerequisite: two semesters college-level biology or equivalent. Recommended: genetics and/or cell biology with laboratory components. Helpful: evolutionary biology, ecology vertebrate/invertebrate zoology. Letter grades only. A two-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. A. Shedlock.

An introduction to basic concepts in systematic biology, evolutionary genetics, molecular ecology, and conservation biology emphasizing the natural history of marine organisms. Students integrate field sampling techniques, taxonomy, and curation of specimens from Appledore Island and surrounding waters with molecular diagnostics completed in the laboratory. Standard methods for DNA purification, amplification, sequencing, and genotyping are used to address questions about population structure, kinship, and species phylogeny.

**[BIOSM 4770 Marine Vertebrates**

Summer. 6 credits. Prerequisites: vertebrate biology course or equivalent course at level from which applicant can demonstrate knowledge of basic vertebrate anatomy, physiology, and systematics, or permission of instructor. S-U or letter grades. A three-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec, lab, and fieldwork for three weeks. Next offered 2011–2012. J. Heiser.]

**[BIOSM 4950 Research Methods in Marine Biology**

Summer. 1 credit. Corequisite: BIOSM 4990 or permission of instructor. Primarily for undergraduates. An eight-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Weekly sem for eight weeks. Next offered 2011–2012. SML faculty.]

**BIOSM 4990 Research in Biology**

Summer. Variable credit; 2 credits per seven days on site. A three-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. SML faculty.

**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.

**[BIOSM 6500 Field Marine Ecology and Environmental Science for Teachers**

Summer. 2 credits. Prerequisites: two semesters college-level biology or equivalent. Recommended: teaching experience. A one-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Daily lec and fieldwork for one week. Next offered 2011–2012. SML faculty.]

**[BIOSM 6990 Research in Biology for Teachers**

Summer. 2 credits per week. Prerequisite: BIOSM 6500. One-week course offered at Shoals Marine Laboratory (SML), on Appledore Island in the Gulf of Maine. Next offered 2011–2012.]

**SEA SEMESTER**

Sea Education Association (SEA) offers three semester-length sequences of courses designed to provide college undergraduates with a thorough academic, scientific, and practical understanding of the sea. *These sequences are 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, Mass., 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. **No prior sailing experience is necessary.** Cornell students enrolled in the SEA Semester must take the entire sequence.

For more information, contact Sea Education Association, www.sea.edu, P.O. Box 6, Woods Hole, MA 02543 or call 800-552-3633 ext. 770. Program costs are to be paid in place of regular Cornell tuition and fees.

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

**SEA: Ocean Exploration**

**SEA 3660 Introduction to Oceanography**

3 credits. Corequisites: BIOSM 3670 and 3680.

Survey of the characteristics and processes of the global ocean. Introduces oceanographic concepts and develops them 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.

**SEA 3670 Introduction to Maritime Studies**

3 credits. Corequisites: BIOSM 3660 and 3680.

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.

**SEA 3680 Introduction to Nautical Science**

3 credits. Corequisites: BIOSM 3660 and 3670.

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 3690 Practical Oceanography I**

4 credits. Prerequisite: BIOSM 3660.

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.

**SEA 3700 Practical Oceanography II**

4 credits. Prerequisites: BIOSM 3680 and 3690.

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.

**SEA 3720 Practical Oceanography III**

Summer. 3 credits. Prerequisites: BIOSM 3660, 3670, and 3680.

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.

#### SEA: Oceans and Climate

##### SEA 3680 Introduction to Nautical Science

##### SEA 3780 Oceans and Climate: Oceans in the Global Carbon Cycle

Fall, spring. 4 credits. Prerequisite: 3 lab science courses or permission of instructor. SML faculty.

This course examines the role of the oceans in the climate system, addressing topics such as the global carbon cycle, the thermohaline circulation, and aspects of global change including warming and sea level rise.

##### SEA 3790 Ocean Science and Public Policy (HA)

Fall, spring. 3 credits. SEA faculty.  
This course seeks to provide students with a fundamental understanding of the intersection between climate change and governmental policy and the interrelationship between science and governmental policy. After an introduction to the development of maritime law and sovereignty on the high seas, students will examine why societies funded oceanic research.

##### SEA 3800 Oceanographic Field Methods

Fall, spring. 3 credits. Prerequisite: successful completion of BIOSM 3780. SEA faculty.

This course introduces students to all aspects of oceanographic fieldwork. Students learn practical skills in the operating principles and safe deployment of oceanographic instrumentation. Skills acquired enable students to carry out an independent research project.

##### SEA 3810 Independent Research in Oceans and Climate

Fall, spring. 4 credits. Prerequisite: successful completion of BIOSM 3780. SEA faculty.

This course provides upper-level study focused on oceanography and climate, including the design and completion of an independent research project that is comparable in scope to an undergraduate senior research thesis.

#### SEA: Documenting Change in the Caribbean

##### SEA 3620 Maritime History and Culture (CA) (HA)

Fall, spring. 4 credits. SEA faculty.  
In this course, students will explore political, cultural and social changes in the Caribbean since just before Europeans arrived at the end of the 15th century. Student will see how the physical nature of the region has influenced patterns of settlement and development and the impact of European expansion.

##### SEA 3660 Practical Oceanography I

##### SEA 3680 Introduction to Nautical Science

##### SEA 3700 Practical Oceanography II

##### SEA 3710 Marine Environmental History (CA) (LA)

Fall, spring. 4 credits. SEA faculty.  
This course is designed to explore the interaction of ecological factors in ocean, coastal and island environments; the impact of

human actions on those environments; and the need for local, regional and international responses and strategies to mitigate and manage that impact.

## FACULTY ROSTER

### New York State College of Agriculture and Life Sciences

- Adler, Craig K., Ph.D., U. of Michigan. Prof., Neurobiology and Behavior  
Agrawal, Anurag, Ph.D., U. of California, Davis. Assoc. Prof., Ecology and Evolutionary Biology/Entomology  
Alani, Eric E., Ph.D., Harvard U. 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. Assoc. Prof., Microbiology  
Barbash, Daniel A., Ph.D., U. of California, Berkeley. Asst. Prof., Molecular Biology and Genetics  
Bates, David M., Ph.D., U. of California, Los Angeles. Prof. Emeritus, Plant Biology (Bailey Hortorium)  
Bemis, William E., Ph.D., U. of California, Berkeley. Prof., Ecology and Evolutionary Biology/Shoals Marine Laboratory  
Bradbury, Jack W., Ph.D., Rockefeller U. Prof. Emeritus, Neurobiology and Behavior  
Bruns, Peter J., Ph.D., U. of Illinois. Prof. Emeritus, Molecular Biology and Genetics  
Cade, Thomas J., Ph.D., U. of California, Los Angeles. Prof. Emeritus, Ecology and Evolutionary Biology  
Calvo, Joseph M., Ph.D., Washington State U. William T. Keeton Professor Emeritus 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 (UK). 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 Emeritus, Neurobiology and Behavior\*  
Emlen, Stephen T., Ph.D., U. of Michigan. Jacob Gould Schurman Professor Emeritus, Neurobiology and Behavior  
Feeny, Paul P., Ph.D., Oxford U. (UK). Prof. Emeritus, 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. Assoc. Prof., Ecology and Evolutionary Biology  
Fox, Thomas D., Ph.D., Harvard U. Prof., Molecular Biology and Genetics  
Fromme, Joseph C., Ph.D., Harvard U. Asst. Prof., Molecular Biology and Genetics  
Ghiorse, William C., Ph.D., Rensselaer Polytechnic Inst. Prof., Microbiology  
Gibson, Jane, Ph.D., U. of London (UK). 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. Assoc. Prof., Microbiology  
Helmann, John D., Ph.D., U. of California, Berkeley. Prof., Microbiology  
Henry, Susan, Ph.D., U. of California, Berkeley. Prof., Molecular Biology and Genetics  
Hewson, Ian, Ph.D., U. of S. California. Asst. Prof., Microbiology  
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 of Ecology and Environmental Biology, Ecology and Evolutionary Biology  
Hua, Jian, Ph.D., California Inst. of Technology. Asst. Prof., Plant Biology  
Ingram, John W., Ph.D., U. of California, 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. and Chair, Molecular Biology and Genetics  
Kessler, André, Ph.D., Max Planck Inst. for Chemical Ecology/Friedrich Schiller U. of Jena (Germany). Asst. Prof., Ecology and Evolutionary Biology/Boyce Thompson Inst. for Plant Research  
Kingsbury, John M., Ph.D., Harvard U. Prof. Emeritus, Plant Biology  
Ley, Ruth E., Ph.D., U. of Colorado. Asst. Prof., Microbiology  
Lis, John T., Ph.D., Brandeis U. Barbara McClintock Professor of Molecular Biology and Genetics  
Lovette, Irby J., Ph.D., U. of Pennsylvania. Assoc. Prof., Ecology and Evolutionary Biology/Laboratory of Ornithology  
Luckow, Melissa A., Ph.D., U. of Texas, Austin. Assoc. Prof., Plant Biology (Bailey Hortorium)  
MacDonald, Russell E., Ph.D., U. of Michigan. Prof. Emeritus, Molecular Biology and Genetics  
MacIntyre, Ross J., Ph.D., Johns Hopkins U. Prof. Emeritus, Molecular Biology and Genetics  
Madsen, Eugene L., Ph.D., Cornell U. Prof., Microbiology  
Marks, Peter L., Ph.D., Yale U. Prof. Emeritus, Ecology and Evolutionary Biology  
McCune, Amy R., Ph.D., Yale U. 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  
 Niklas, Karl J., Ph.D., U. of Illinois. Prof., Plant Biology  
 Nixon, Kevin C., Ph.D., U. of Texas, 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, Davis. Prof. Emeritus, Plant Biology  
 Parthasarathy, Mandayam V., Ph.D., Cornell U. Prof. Emeritus, Plant Biology  
 Peters, Joseph, Ph.D., U. of Maryland. Assoc. Prof., Microbiology  
 Raguso, Robert A., Ph.D., U. of Michigan. Assoc. Prof., Neurobiology and Behavior  
 Reeve, H. Kern, Ph.D., Cornell U. 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, Berkeley. Prof. Emeritus, Ecology and Evolutionary Biology/Entomology  
 Rose, Jocelyn, Ph.D., U. of California, Davis. Assoc. Prof., Plant Biology  
 Scanlon, Michael, Ph.D., Iowa State U. Assoc. Prof., Plant Biology  
 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. Assoc. Prof., Microbiology  
 Smolka, Marcus B., Ph.D., State U. of Campinas (Brazil). Asst. Prof., Molecular Biology and Genetics  
 Tye, Bik-Kwoon, Ph.D., Massachusetts Inst. of Technology. Prof., Molecular Biology and Genetics  
 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). Assoc. Prof., Plant Biology  
 Vogt, Volker M., Ph.D., Harvard U. Prof., Molecular Biology and Genetics  
 Walcott, Charles, Ph.D., Cornell U. Prof. Emeritus, Neurobiology and Behavior  
 Wayne, Randy O., Ph.D., U. of Massachusetts. Assoc. Prof., Plant Biology  
 Winans, Stephen C., Ph.D., Massachusetts Inst. of Technology. Prof., Microbiology  
 Winkler, David W., Ph.D., U. of California, Berkeley. Prof., Stephen H. Weiss Presidential Fellow, Ecology and Evolutionary Biology  
 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

Blankenship, James E., M.S., Cornell U. Sr. Lec., Molecular Biology and Genetics  
 Calvo, Rita A., Ph.D., Cornell U. Courtesy Sr. Lec., Molecular Biology and Genetics  
 Chen, Kuei-chiu, Ph.D., New York U. Lec., Neurobiology and Behavior  
 Ely, Susan, Ph.D., Tufts U. Sr. Lec., Molecular Biology and Genetics  
 Hester, Laurel, Ph.D., U. Michigan. Lec., Neurobiology and Behavior  
 McGuire, Betty A., Ph.D., U. of Massachusetts. Sr. Lec., Ecology and Evolutionary Biology

Merkel, Susan, M.S., Cornell U. Sr. Lec., Microbiology  
 Nivison, Helen T., Ph.D., U. of California, Davis. Sr. Lec., Molecular Biology and Genetics  
 Rehkugler, Carole M., M.S., Cornell U. Sr. Lec., Microbiology  
 Silva, Thomas, Ph.D., Cornell U. Sr. Lec., Plant Biology  
 Southard, Laurel E., M.S., Tulane U. Lec., Undergraduate Biology

#### Joint Appointees

Bloom, Stephen E., Prof., Veterinary/Microbiology and Immunology  
 Brutnell, Thomas, Prof., Plant Breeding/Plant Biology  
 Doyle, Jeffrey J., Prof., Plant Biology (Bailey Hortorium)/Plant Biology General  
 Giovannoni, James G., Adjunct Asst. Prof., USDA Science and Education Administration/Plant Biology  
 Hanson, Maureen, Prof., Molecular Biology and Genetics/Plant Biology  
 Hrazdina, Geza, Prof. Emeritus, Food Science and Technology Geneva/Plant Biology  
 Jander, Georg, Adjunct Asst. Prof., Boyce Thompson Inst./Plant Biology  
 Kochian, Leon V., Adjunct Prof., USDA Science and Education Administration/Plant Biology  
 Koenig, Walter D., Sr. Scientist, Laboratory of Ornithology  
 Korf, Richard P., Prof. Emeritus, Plant Pathology/Plant Biology (Bailey Hortorium)  
 Lee, Ji-Young, Adjunct Prof., Boyce Thompson Institute/Plant Biology  
 Lieberr, James K., Assoc. Prof., Entomology/Plant Biology (Bailey Hortorium)  
 McCouch, Susan R., Assoc. Prof., Plant Breeding/Plant Biology  
 Pimentel, David, Prof. Emeritus, Entomology/Ecology and Evolutionary Biology  
 Richards, Eric J., Adjunct Prof., Boyce Thompson Institute/Molecular Biology and Genetics  
 Rossman, Michael J., Adjunct Prof., Purdue U./Molecular Biology and Genetics  
 Schimanti, John, Prof., Biomedical Sciences  
 Stern, David B., Adjunct Prof., Boyce Thompson Institute/Plant Biology  
 Tanksley, Steven, Prof., Plant Breeding/Liberty Hyde Bailey Prof., Plant Biology  
 Thaler, Jennifer S., Assoc. Prof., Entomology/Ecology and Evolutionary Biology  
 Thompson, John F., Adjunct Prof., USDA Science and Education Administration/Plant Biology  
 Vehrencamp, Sandra, Prof., Neurobiology and Behavior/Library of Natural Sounds  
 Wang, Haiyang, Adjunct Asst. Prof., Boyce Thompson Inst./Plant Biology  
 Webster, Michael S., Assoc. Prof., Neurobiology and Behavior/Library of Natural Sounds

#### 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. Charles A. Alexander Professor of Biological Sciences, 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 (UK). Prof., Molecular Biology and Genetics, Emeritus  
 Booker, Ronald, Ph.D., Princeton U. Assoc. Prof., Neurobiology and Behavior

Bretscher, Anthony P., Ph.D., Leeds U. (UK). Prof., Molecular Biology and Genetics and Assoc. Dir., Inst. of Cell and Molecular Biology  
 Brown, William J., Ph.D., U. of Texas Health Science Center, Dallas. Prof., Molecular Biology and Genetics  
 Clark, Andrew G., Ph.D., Stanford U. Jacob Gould Schurman Professor of Population Genetics, Molecular Biology and Genetics/Ecology and Evolutionary Biology  
 Deitcher, David, Ph.D., Harvard Medical School. Assoc. Prof., Neurobiology and Behavior  
 Ellner, Stephen P., Ph.D., Cornell U. Prof., Ecology and Evolutionary Biology  
 Emr, Scott, Ph.D., Harvard U. Frank H. T. Rhodes Class of '56 Endowed Director of the new Cornell Institute of Cell and Molecular Biology  
 Feigenson, Gerald W., Ph.D., California Inst. of Technology. Prof., Molecular Biology and Genetics  
 Fetcho, Joseph R., Ph.D., U. of Michigan. Prof., Neurobiology and Behavior  
 Finlay, Barbara, Ph.D., Massachusetts Inst. of Technology. Prof., Psychology  
 Garcia Garcia, Maria J., Ph.D., U. Autonoma de Madrid (Spain). Asst. Prof., Molecular Biology and Genetics  
 Geber, Monica A., Ph.D., U. of Utah. Prof., Ecology and Evolutionary Biology  
 Gibson, Quentin H., Ph.D./D.Sc., Queen's U. (Northern Ireland). Greater Philadelphia Professor Emeritus in Biological Sciences, Molecular Biology and Genetics  
 Goodale, Christine L., Ph.D., U. of New Hampshire. Asst. Prof., Ecology and Evolutionary Biology  
 Greene, Harry W., Ph.D., U. of Tennessee. Prof., Ecology and Evolutionary Biology  
 Grimson, Andrew W., Ph.D., U. of Wisconsin, Madison. Asst. Prof., Molecular Biology and Genetics  
 Hairston, Nelson G., Jr., Ph.D., U. of Washington. Frank H. T. Rhodes Professor of Environmental Science, Ecology and Evolutionary Biology  
 Halpern, Bruce P., Ph.D., Brown U. Prof., Neurobiology and Behavior/Psychology  
 Heppel, Leon A., Ph.D., U. of California, Berkeley. Prof. Emeritus, Molecular Biology and Genetics  
 Hess, George P., Ph.D., U. of California, Berkeley. Prof. Emeritus, Molecular Biology and Genetics  
 Hinkle, Peter C., Ph.D., New York U. Prof., Molecular Biology and Genetics  
 Howland, Howard C., Ph.D., Cornell U. Prof. Emeritus, Neurobiology and Behavior  
 Hoy, Ronald R., Ph.D., Stanford U. Merksamer Prof., Neurobiology and Behavior  
 Huffaker, Tim C., Ph.D., Massachusetts Inst. of Technology. Prof. and Assoc. Chair, Molecular Biology and Genetics  
 Ke, Ailong, Ph.D., Johns Hopkins U. School of Medicine. Asst. Prof., Molecular Biology and Genetics  
 Kennedy, Kenneth A. R., Ph.D., U. of California, Berkeley. Prof. Emeritus, Ecology and Evolutionary Biology  
 Lee, Siu Sylvia, Ph.D., Baylor Coll. of Medicine. Assoc. Prof., Molecular Biology and Genetics  
 Linster, Christine, Ph.D., Pierre and Marie Curie U. (France). Assoc. Prof., Neurobiology and Behavior  
 Liu, Jun Kelly, Ph.D., Cornell U. Assoc. Prof., Molecular Biology and Genetics  
 McCobb, David, Ph.D., U. of Iowa. Assoc. 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

Mao, Yuxin, Ph.D., Baylor College of Medicine. Asst. Prof., Molecular Biology and Genetics

Nicholson, Linda, Ph.D., Florida State U. Prof., Molecular Biology and Genetics

Pleiss, Jeffrey, Ph.D., U. of Colorado. Asst. Prof., Molecular Biology and Genetics

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. Andrew H. and James S. Tisch Distinguished University Professor, Ecology and Evolutionary Biology/History

Seeley, Thomas D., Ph.D., Harvard U. Prof., Neurobiology and Behavior

Shaw, Kerry L., Ph.D., Washington U., St. Louis. Prof., Neurobiology and Behavior

Sherman, Paul W., Ph.D., U. of Michigan. Prof., Neurobiology and Behavior

Sparks, Jed P., Ph.D., Washington State U. Assoc. Prof., Ecology and Evolutionary Biology

Tumbar, Tudorita, Ph.D., U. of Illinois, Urbana-Champaign. Asst. Prof., Molecular Biology and Genetics

Turgeon, Robert, Ph.D., Carleton U. (Canada). Prof., Plant Biology

Wallace, Bruce, Ph.D., Columbia U. Prof. Emeritus, Molecular Biology and Genetics

Wilson, David B., Ph.D., Stanford U. Prof., Stephen H. Weiss Presidential Fellow, 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. Assoc. Prof., Ecology and Evolutionary Biology

#### Other Teaching Personnel

Balko, Elizabeth A., Ph.D., College of Environmental Science and Forestry. Sr. Lec., Plant Biology

Johnson, Bruce R., Ph.D., Boston U. Sr. Lec., Neurobiology and Behavior

#### Joint Appointees

Levin, Simon A., Adjunct Prof., Princeton U./Ecology and Evolutionary Biology

Likens, Gene E., Adjunct Prof., Cary Institute of Ecosystem Studies/Ecology and Evolutionary Biology

#### College of Veterinary Medicine

Beyenbach, Klaus W., Ph.D., Washington State U. Prof., Biomedical Sciences

Bezuidenhout, Abraham, D.V.Sc., U. of Pretoria (South Africa), Sr. Lec., Biomedical Sciences

Buckles, Elizabeth, D.V.M., Ph.D., U. of Wisconsin. Asst. Prof., Biomedical Sciences

Catalfamo, James, M.S., Ph.D., Union Coll. Sr. Res. Assoc., Population Medicine and Diagnostic Services

Chuang, Huai-hu, Ph.D., U. of California. Asst. Prof., Biomedical Sciences

Cohen, Paula, Ph.D., U. of London (UK). Assoc. Prof., Biomedical Sciences

Coonrod, Scott, Ph.D., Texas A&M U. Assoc. Prof., Biomedical Sciences

Davison, Robin, Ph.D., U. of Iowa. Prof., Biomedical Sciences

Duhamel, Gerald, D.V.M., Ph.D., U. of California, Davis. Prof., Biomedical Sciences

Farnum, Cornelia E., D.V.M., Ph.D., U. of Wisconsin, Madison. Prof., Biomedical Sciences

Fortune, Joanne E., Ph.D., Cornell U. Prof., Biomedical Sciences

Gilmour, Robert F., Ph.D., SUNY Upstate Medical Center. Prof., Biomedical Sciences

Gleed, Robin, BVSc, MRCVS, U. of Liverpool (UK). Assoc. Prof., Clinical Sciences

Hermanson, John W., M.S., Ph.D., U. of Florida, Gainesville. Assoc. Prof., Biomedical Sciences

Kotlikoff, Michael I., Ph.D., U. of California, Davis. Prof., Biomedical Sciences

Lin, David, Ph.D., U. of California, Berkeley. Assoc. Prof., Biomedical Sciences

Loew, Ellis R., Ph.D., U. of California, Los Angeles. Prof., Biomedical Sciences

Ludders, John, D.V.M., Washington State U. Prof., Clinical Sciences

McDonough, Sean, D.V.M., Ph.D., U. of Pennsylvania. Assoc. Prof., Biomedical Sciences

Meyers-Wallen, Vicki, V.M.D., Ph.D., U. of Pennsylvania. Assoc. Prof., Biomedical Sciences

Mizer, Linda, D.V.M., Ph.D., Ohio State U. Sr. Lec., Biomedical Sciences

Nikitin, Alexander Yu, M.D., Ph.D., Petrov Research Inst. of Oncology (Russia). Assoc. Prof., Biomedical Sciences

Noden, Drew M., Ph.D., Washington U. (St. Louis). Prof., Biomedical Sciences

Oswald, Robert, Ph.D., Vanderbilt U. Prof., Molecular Medicine

Peters-Kennedy, Jeanine, D.V.M., U. of Georgia. Asst. Prof., Biomedical Sciences

Quaroni, Andrea, Ph.D., U. of Pavia (Italy). Prof., Biomedical Sciences

Rawson, Richard E., D.V.M., Ph.D., U. of Minnesota. Sr. Lec., Biomedical Sciences

Roberson, Mark, Ph.D., U. of Nebraska. Prof., Biomedical Sciences

Schimenti, John, Ph.D., U. of Cincinnati. Prof., Biomedical Sciences

Schlafer, Donald H., D.V.M., Ph.D., U. of Georgia. Prof., Biomedical Sciences

Southard, Teresa, D.V.M., Ph.D., U. of Wisconsin, Madison. Asst. Prof., Biomedical Sciences

Suarez, Susan, Ph.D., U. of Virginia. Prof., Biomedical Sciences

Travis, Alexander J., V.M.D., Ph.D., U. of Pennsylvania. Assoc. Prof., Biomedical Sciences

Weiss, Robert S., Ph.D., Baylor Coll. of Medicine. Assoc. Prof., Biomedical Sciences

Yen, Andrew, Ph.D., Cornell U. Prof., Biomedical Sciences

#### Other Teaching Personnel

Jordan, Antonia, Ph.D., Cornell U. Lec., Biomedical Sciences

Lorr, Nancy, Ph.D., U. of Oregon. Lec., Biomedical Sciences

Maza, Paul, D.V.M., U. of St. Kitts (West Indies). Lec., Biomedical Sciences

#### College of Engineering

##### Joint Appointees

Cisne, John L., Assoc. Prof., Geological Sciences/Biological Sciences

Webb, Watt W., Prof., Applied and Engineering Physics/Biological Sciences

#### Division of Nutritional Sciences

##### Joint Appointees

Arion, William J., Prof., Nutritional Sciences/Molecular Biology and Genetics

Kazarinoff, Michael N., Assoc. Prof., Nutritional Sciences/Molecular Biology and Genetics

Wright, Lemuel D., Prof. Emeritus, Nutritional Sciences/Molecular Biology and Genetics

\*Joint appointment with College of Arts and Sciences

†Joint appointment with College of Veterinary Medicine

‡Joint appointment with College of Agriculture and Life Sciences

§Joint appointment with College of Engineering