DIVISION OF BIOLOGICAL SCIENCES

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

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

ORGANIZATION

The Division of Biological Sciences is composed of seven sections: Biochemistry, Molecular and Cell Biology; Ecology and Systematics; Genetics and Development; Microbiology; Neurobiology and Behavior; Physiology; Plant Biology; and, in addition, the L. H. Bailey Hortorium and the Shoals Marine Laboratory.

The offices, research laboratories, and classrooms of biology faculty members are located in many different buildings on the campus, primarily in the Colleges of Agriculture and Life Sciences, Arts and Sciences, and Veterinary Medicine.

Student services are provided by the division's Office for Academic Affairs and the Behrman Biology Center, both located in Stimson Hall, where academic advice, information on biological sciences course offerings, other important information, and counseling are available for undergraduates. The Office for Academic Affairs also follows the progress of biology majors and works closely with faculty advisers. Additional services and resources of the Biology Center include academic program planning, tutoring, lecture tapes, examination files, and information on undergraduate research opportunities. The center has comfortable areas for studying and relaxing.

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

FACULTY

P. J. Bruns, director; H. T. Stinson, associate director; K. K. Adler, C. F. Aquadro, W. J. Arion, R. Barker, A. H. Bass, D. M. Bates, A. Bensadoun, K. W. Beyenbach, A. W. Blackler, S. E. Bloom, R. Booker, A. C. Borror, A. P. Bretscher, W. J. Brown, W. L. Brown, W. R. Butler, J. M. Calvo, R. R. Capranica, B. F. Chabot, J. L. Cisne, R. A. Corradino, W. L. Crepet, W. B. Currie, P. J. Davies, J. I. Davis, T. E. Dawson, A. Dobson, J. J. Doyle, T. Eisner, S. T. Emlen, P. P. Feeny, G. W. Feigenson, R. H. Foote, J. E. Fortune, T. D. Fox, M. A. Geber, W. C. Ghiorse, J. Gibson, Q. H. Gibson, R. F. Gilmour, M. L. Goldberg, N. G. Hairston, B. P. Halpern, O. P. Hamill, M. R. Hanson, R. G. Harrison, R. M. Harris-Warrick, C. D. Harvell, J. D. Helmann, L. A. Heppel, G. P. Hess, P. C. Hinkle, C. D. Hopkins, K. A. Houpt, T. R. Houpt, R. W. Howarth, S. H. Howell, H. C. Howland, R. R. Hoy, T. C. Huffaker, A. T. Jagendorf, P. A. Karplus, M. N. Kazarinoff, E. B. Keller, K. J. Kemphues, K. A. R. Kennedy, L. V. Kochian, R. P. Korf, T. A. LaRue, R. L. Last, A. C. Leopold, S. A. Levin, G. E. Likens, J. T. Lis, E. R. Loew, M. A. Luckow, R. E. McCarty, D. K. McClearn, A. R. McCune, J. M. Fessenden MacDonald, R. J. MacIntyre, W. H. Mark, P. L. Marks, R. P. Mortlock, J. B. Nasrallah, K. J. Niklas, K. C. Nixon, T. G. Owens, D. J. Paolillo, M. V. Parthasarathy, D. Pimentel, T. R. Podleski, F. H. Pough, A. G. Power, W. B. Provine, A. Quaroni, E. Racker, E. Adkins Regan, M. E. Richmond, J. W. Roberts, D. Robertshaw, R. B. Root, J. B. Russell, M. M. Salpeter, A. M. Schneiderman, T. D. Seeley, D. I. Shalloway, P. W. Sherman, R. B. Silver, R. M. Spanswick, D. B. Stern, V. J. Stewart, D. N. Tapper, J. F. Thompson, R. Turgeon, B.-K. Tye, S. Via, V. M. Vogt, C. Walcott, R. H. Wasserman, R. O. Wayne, W. W. Webb, N. F. Weeden, Q. D. Wheeler, D. B. Wilson, S. C. Winans, D. W. Winkler, M. F. Wolfner, J. F. Wootton, R. Wu, S. A. Zahler, S. H. Zinder

Other Teaching Personnel

G. Albrecht, R. R. Alexander, R. A. Calvo, M. L. Cordts, C. Eberhard, P. R. Ecklund, M. F. Ferger, J. C. Glase, J. M. Griffiths, J. B. Heiser, A. C. Huntley, C. H. McFadden, C. M. Ruhkugler, H. C. Reiss

DISTRIBUTION REQUIREMENT

In the College of Agriculture and Life Sciences, the biological sciences distribution requirement (Group B) is for a minimum of 9 credits, including at least 6 credits of introductory biology satisfied by Biological Sciences 109–110,105–106, or 101 and 103 plus 102 and 104, or 107–108. Advanced placement in biology with a score of 4 or 5 (6 or 8 credits, respectively) satisfies the requirement for introductory biology. The additional credits may be satisfied by any biological sciences courses *except Biological Sciences 152, 200, 202, 205, 206, 208, 209, 301, or 367.*

In the College of Arts and Sciences, the biological sciences distribution requirement is for a two-semester introductory biology sequence selected from Biological Sciences 109–110,105–106, or 101 and 103 plus 102 and 104, or 107–108. An Advanced Placement score of 4 or 5 fulfills one-half the distribution requirement. Students must take an upper-level biology course to complete the distribution requirement in biological sciences. The remainder of the distribution requirement may be satisfied by an upper-level course (200+) offered by the Division of Biological Sciences *other than Biological Sciences 152, 200, 202, 205, 206, 208, 209, 301, or 367*; Anthropology 101; or Chemistry 222.

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

Note: Biological Sciences 101–102–103–104 should be taken as a unit by students of any college except those with advanced placement credit.

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

THE MAJOR

The Division of Biological Sciences offers a major in biological sciences to students enrolled in either the College of Agriculture and Life Sciences or the College of Arts and Sciences. The undergraduate program is coordinated for students in both colleges through the division's Office for Academic Affairs, where students submit their applications to the major and obtain biology faculty advisers.

During the second semester of the sophomore year, all students who intend to major in biological sciences must apply for acceptance into the major with the associate director for academic affairs, in 200 Stimson Hall. Students in the College of Agriculture and Life Sciences who were admitted directly to the major complete the application process to declare a concentration area and to assure satisfactory progress toward completion of the major. Acceptance into the major requires completion of the course sequences in introductory biology, chemistry, and mathematics (see requirements 1–3 below), plus one semester of organic chemistry lectures. In addition, a 2.75 Cornell cumulative grade-

point average is required for final acceptance into the major except for those students admitted directly to the major as freshmen (College of Agriculture and Life Sciences students only) or as transfers. Students in the process of completing these prerequisites for admission to the major may be accepted on a *provisional* basis. Final acceptance into the major is required for graduation with a biological sciences major. It is the student's responsibility to assure that final acceptance has been granted.

Whenever possible, students should include the introductory biology, chemistry, and mathematics sequences in their freshman schedule and complete the organic chemistry lecture course in their sophomore year. Students are not encouraged to continue with the major in biological sciences unless performance in these four subjects gives evidence of capacity to perform satisfactorily at a more advanced level.

The requirements for the biological sciences major are listed below. These courses should be taken for a letter grade, unless the course is offered for S-U grades only.

1) **Introductory biology for majors** (one year): Biological Sciences 101 and 103 plus 102 and 104, or 105–106. Biological Sciences 107–108, offered during the eight-week Cornell Summer Session for 8 credits, also satisfies the introductory biology requirement for majors. Students may choose to accept advanced placement if they have received a score of 5 on the Advanced Placement Examination of the College Entrance Examination Board (CEEB). Students with a score of 4 must fulfill the introductory biology requirement by taking Biological Sciences 101–102, 101 and 103, 102 and 104, or 103–104. These students should consult information available in the course office (1140 Comstock Hall) and in the Biology Center (216-222 Stimson Hall) to determine which semester to take to complete the introductory biology requirement. For students in doubt, Biological Sciences 101 and 103 is advised. These students receive a total of 8 introductory biology credits (4 AP credits plus 4 course credits).

2) **General chemistry** (one year): Chemistry 207–208,* or 215–216,* or 103–104.

3) **College mathematics** (one year): Two semesters of calculus (Mathematics 111–112, 191–192, or their equivalents) or Mathematics 105 and one semester of calculus. Education 115 may not be used to fulfill any part of this requirement.

4) **Organic chemistry**: Chemistry 253 and 251, or 253 and 301, or 357–358 and 251, or 357–358 and 301, or 359–360 and 251, or 359–360 and 301.

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

6) **Genetics:** Biological Sciences 281.

7) **Biochemistry:** Biological Sciences 330 or 331.

8) **Evolutionary Biology:** Biological Sciences 378.

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

10) **Foreign language:** students registered in the College of Agriculture and Life Sciences must satisfy the foreign language requirement of the Division of Biological Sciences by (a) presenting evidence of successful completion of three or more years of study of a foreign language in high school or (b) attaining a score of 560 or more on the reading portion of the College Entrance Examination Board achievement test or (c) achieving "qualification" status in a language as defined by the College of Arts and Sciences or (d) successfully completing at least 6 college credits in a foreign language. Students registered in the College of Arts and Sciences must satisfy the language requirement as stated by that college.

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

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

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. The program of study requirements are designed to help students achieve depth in one area of biology while ensuring that the selected advanced courses form a coherent and meaningful unit. Because of the flexibility allowed in satisfying these requirements, students should consult their faculty advisers. The possible programs of study are listed below.

1) *Animal Physiology and Anatomy:* Bio S 311, Introductory Animal Physiology, Lectures; Bio S 313, Histology: The Biology of Tissues; Bio S 315, Topics in Functional Anatomy; Bio S 316, Cellular Physiology; and Bio S 319, Animal Physiology Experimentation. The Program of Study in Animal Physiology and Anatomy emphasizes whole animal, tissue, and cell physiology, and provides considerable opportunity for studies using live animals. It is intended especially for students contemplating careers in biomedical practice or research.

2) *Biochemistry:* Chemistry 300 or 215–216, Quantitative Chemistry, must be taken. One of the following organic chemistry laboratory sequences must also be taken: Chemistry 301–302 or 251–252–302 or 301 or 251–252. In addition, students must take a physical chemistry sequence (Chemistry 389–390 or 287–288.1 or 287–288.2) and a biochemistry laboratory course (Bio S 638 or 430 or 630). Note that Physical Chemistry 288.2 is designed for biologists, but either sequence is appropriate. It is recommended that students take the more rigorous organic chemistry and physics sequences (Chemistry 357–358 or 359–360 and Physics 207–208) and a third semester of calculus. Students interested in biochemistry should complete a year of introductory chemistry other than Chemistry 103–104 before the start of their sophomore year. Students are also urged to complete introductory biology in their freshman year.

3) *Botany:* A minimum of 13 credits is required from courses chosen with the aid of an adviser to meet the goal of exposing each student to plant structure, function, classification, ecology, and evolution. Three courses, one from each of the three following categories, fulfill the minimum requirements. Students are encouraged to begin the sequence of courses with Bio S 241 (see category b): (a) Bio S 242 and 244 or Bio S 341 and 349, Plant Physiology, Lectures and Laboratory; (b) Bio S 241, Introductory Botany; Bio S 248, Taxonomy of Vascular Plants; Bio S 448, Plant Evolution and the Fossil Record; or Pl Pa 309, Introductory Mycology; and (c) Bio S 345, Plant Anatomy; or Pl Pa 301, Introductory Plant Pathology. Students interested in a broad background in botany are encouraged to take Bio S 346, Algal Physiology; Bio S 444, Plant Cell Biology; Bio S 463 and 465, Plant Ecology, Lectures and Laboratory; and additional courses in (b) and (c).

4) *Cell Biology:* Chemistry 300 or 215–216, Quantitative Chemistry; Bio S 432, Survey of Cell Biology; Bio S 630, Laboratory in Cell Biology (strongly recommended), or Bio S 638, Intermediate Biochemical Methods or Bio S 430, Basic Biochemical Methods; and at least 5 additional credits chosen from the following courses: Bio S 222, Neurobiology and Behavior II: Introduction to Neurobiology; Bio S 305, Basic Immunology; Bio S 313, Histology: The Biology of the Tissues; Bio S 345, Plant Anatomy; Bio S 435–436, Undergraduate Biochemistry Seminar; Bio S 437 (438) Oncogenes and Cancer Viruses; Bio S 483, Molecular Aspects of Development; Bio S 444, Plant Cell Biology; Bio S 636, Current Topics in Cell Biology; Bio S 639, The Nucleus; An S 419, Animal Cytogenetics.

   Students interested in cell biology should complete a year of introductory chemistry other than Chemistry 103–104 before the start of their sophomore year. Students are also urged to complete introductory biology in their freshman year. If graduate work in cell biology is anticipated, students should consider taking a physical chemistry sequence (Chemistry 389–390 or 287–288.1 or 287–288.2).

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

   (a) Bio S 241, Introductory Botany; Bio S 274, Functional and Comparative

Morphology of Vertebrates; Bio S 373, The Invertebrates: Form, Function, and Evolution; Bio S 460, Physiological Plant Ecology; Bio S 467, Physiological Animal Ecology; Bio S 471, Mammalogy; Bio S 472, Herpetology; Bio S 475, Ornithology; Bio S 476, Biology of Fishes.

(b) Bio S 263, Field Ecology; Bio S 272, Functional Ecology: How Animals Work; Bio S 448, Plant Evolution and the Fossil Record; Bio S 455, Insect Ecology; Bio S 456, Stream Ecology; Bio S 457 and 459, Limnology, Lectures and Laboratory; Bio S 461, Population and Evolutionary Ecology; Bio S 462, Marine Ecology; Bio S 463 and 465, Plant Ecology and Population Biology, Lectures and Laboratory; Bio S 464, Microevolution and Macroevolution; Bio S 470, Ecological Genetics; Bio S 473, Ecology of Agricultural Systems; Bio S 478, Ecosystem Biology; Bio S 479, Paleobiology; Bio S 481, Population Genetics.

One 400-level, 4-credit course offered at Shoals Marine Laboratory may be applied toward the 10 credits. Students are encouraged to gain experience in some aspect of field biology through course work at a biological field station or work experience.

6) *General Biology:* The program of study in general biology requires a minimum of 13 credit hours from courses offered by the Division of Biological Sciences. These credits must include one course from the courses listed for at least three of the eight other programs of study, and must include a course with a laboratory and a minimum of two upper-level (300 and above) courses of two or more credits.

7) *Genetics and Development:* A minimum of 13 credits, usually chosen from the following courses: Bio S 385, Developmental Biology; Bio S 389, Embryology; Bio S 480, Seminar in Developmental Biology; Bio S 481, Population Genetics; Bio S 482, Human Genetics and Society; Bio S 483, Molecular Aspects of Development; Bio S 484, Molecular Evolution; Bio S 485 and 487, Microbial Genetics; Bio S 633 Biosynthesis of Macromolecules; Bio S 639, The Nucleus; Bio S 641, Laboratory in Plant Molecular Biology; Bio S 644, Plant Growth and Development; Bio S 653, Plant Molecular Genetics; Bio S 684, Advanced Topics in Population Genetics; Bio S 687, Developmental Genetics; Bio S 688, Yeast Genetics; Bio S 695, Bacterial Genetics; An S 419, Animal Cytogenetics; An S 486, Immunogenetics.

   Up to 3 credits for this program of study may be chosen from other biological sciences courses with approval of the faculty adviser.

8) *Microbiology:* Bio S 290, General Microbiology, Lectures; Bio S 291, General Microbiology, Laboratory; Bio S 300, Seminar in Microbiology; and at least 7 credits from the following course list, including at least one course from each group: (a) Bio S 485, Microbial Genetics; or Bio S 416, Microbial Physiology; (b) Bio S 415, Bacterial Diversity; or Bio S 451, Structure and Function of Bacterial Cells; and (c) Bio S 417, Bacterial Diversity, Laboratory; Bio S 418, Microbial Physiology, Laboratory; Bio S 453, Bacterial Cytology, Laboratory; or Bio S 487, Microbial Genetics, Laboratory.

9) *Neurobiology and Behavior:* The two-semester introductory course sequence, Neurobiology and Behavior I and II (Bio S 221 and 222) with discussion section (4 credits per term), and 7 additional credits, among which must be a course from the neurobiology and behavior offerings. Bio S 420, 498, 499, and 720 may not be used as this neurobiology and behavior course. However, these readings and independent research courses may form part of the additional credits (beyond those provided by the advanced neurobiology and behavior course) required to complete the program of study in neurobiology and behavior.

Note: Students who declare the program of study in neurobiology and behavior after taking Bio S 221 or 222 for only 3 credits must complete additional course work in neurobiology and behavior. These students should consult the chair of the Section of Neurobiology and Behavior (W119 Seeley G. Mudd Hall) to determine what course(s) to use to make up the deficiency.

10) *Independent Option:* Special program for students interested in nutrition is available under this option. In addition, students who want to undertake a course of study not covered by the nine existing programs of study or one of the special programs may petition the Division of Biological Sciences Curriculum Committee. Information on independent options and Curriculum Committee petition forms are available in the Office for Academic Affairs, 200 Stimson Hall.

Independent Research and Honors Program

Individual research projects under the direction of a faculty member are encouraged as an aspect of study within a program of study. Applicants for research projects are accepted by the individual faculty members, who take into account students' previous academic accomplishments, interests, and goals and the availability of space and equipment suitable for the proposed project. Students accepted for independent research enroll for credit in Biological Sciences 499 (Undergraduate Research in Biology) with the written permission of the faculty supervisor. Students register for this course in 200 Stimson Hall. Any faculty member in the Division of Biological Sciences may act as a supervisor. Faculty supervisors outside the division are acceptable only if a faculty member of the division agrees to take full responsibility for the quality of the work. Information on faculty research activities and undergraduate research opportunities is available in the Behrman Biology Center, 216-222 Stimson Hall.

Research credits may not be used in completion of the following program of study areas: animal physiology and anatomy; biochemistry; botany; cell biology; ecology and evolutionary biology; genetics and development; and microbiology. No more than 4 credits of research may be used in completion of the program of study in neurobiology and behavior.

The honors program in biological sciences is designed to offer advanced training in laboratory or field research through the performance of an original research project under the direct guidance of a member of the faculty. Applications for the honors program are available in the Office for Academic Affairs, 200 Stimson Hall, and must be submitted to the Honors Program Committee by the deadline announced early in the senior year. Application forms for the honors program are separate from the enrollment forms for Biological Sciences 499 (Undergraduate Research in Biology). 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 an overall Cornell cumulative grade-point average of at least 3.00. In addition, students must have at least a 3.00 Cornell cumulative grade-point average in all biology, chemistry, mathematics, and physics courses. (Grades earned in courses in other departments that are used to fulfill major requirements are included in this computation.) In addition, candidates must have a faculty member to supervise their research. Any faculty member in the Division of Biological Sciences may act as a supervisor. Students may also work with faculty supervisors outside the division. Students who select supervisors outside the division must arrange for a faculty member of the division to serve as cosigner of the research. The division cosigner must agree to meet with the student on a regular basis, to report to the Honors Program Committee on the progress of the work approximately two months before the thesis is due, and to serve as a reviewer of the thesis. An honors candidate usually enrolls for credit in Biological Sciences 499 (Undergraduate Research in Biology) under the direction of the faculty member acting as honors supervisor, although it is not necessary to do so. Students choosing to earn credit for honors research must enroll in Biological Sciences 499 (Undergraduate Research in Biology) separate from the honors program. Requirements of the honors program include participation in honors research seminars during two semesters, submission of an acceptable honors thesis, completion of all major requirements, and maintenance of the 3.00 Cornell cumulative grade-point average through graduation. Recommendation to the faculty that a candidate graduate with honors is the responsibility of the Honors Program Committee.

Students interested in the honors program should consult their faculty advisers early during their junior year. Students are strongly encouraged to begin their research projects in their junior year, although they are not formally admitted to the honors program until the beginning of their senior year. Students who are considering a year abroad should consult with a member of the Honors Committee before beginning their year abroad. Details pertaining to thesis due dates, seminars, and other requirements may be obtained from the chair of the Honors Program Committee or from the Office for Academic Affairs, 200 Stimson Hall. Information on faculty research activities is available in the Behrman Biology Center, 216-222 Stimson Hall.

CURRICULUM COMMITTEE

Many decisions pertaining to the curriculum, to division-wide requirements, and to the programs of study are made by the Curriculum Committee of the division. The committee consists of faculty and elected student members and welcomes advice and suggestions from all interested persons.

ADVISING

Students in need of academic advice are encouraged to consult their advisers, come to the Behrman Biology Center (216-222 Stimson Hall), or contact the associate director for academic affairs (200 Stimson Hall).

Students interested in marine biology should visit the Cornell Marine Programs Office, G14 Stimson Hall.

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

INDEX OF COURSES

The middle digits of biological sciences course numbers are used to denote courses in specific areas: 0, general or microbiology; 1, animal physiology and anatomy or microbiology; 2, neurobiology and behavior; 3, biochemistry or cell biology; 4, botany; 6 and 7, ecology, systematics, and evolution; 8, genetics and development; 9, microbiology, or neurobiology and behavior. The middle digit 5 is used when all other course numbers in a particular area have already been assigned.

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

Current and Former Course Numbers

GENERAL COURSES

BIO S 101–102 Biological Sciences, Lectures

101, fall; 102, spring. 2 credits each term. Prerequisite: concurrent enrollment in Biological Sciences 103 (fall) or 104 (spring). Passing grade (D or better) in 101 is prerequisite to 102 unless written permission is obtained from instructor. S-U grades optional, with permission of instructor. May not be taken for credit after Biological Sciences 105–106 or 109–110.

Lecs, M W F 9:05 or 10:10. 2 lecs each week; to accommodate these, students must reserve all 3 days. Evening prelims: fall, Sept. 26 and Nov. 7; spring, Feb. 20 and Mar. 31. C. D. Hopkins.

Designed both for students who intend to specialize in biological sciences and for those specializing in other subjects, such as the social sciences or humanities, who want to obtain a thorough knowledge of biology as part of their general education. Plant and animal materials are considered together rather than in separate units. The fall semester covers the chemical and cellular basis of life, energy transformations, anatomy, physiology, and behavior. The spring semester covers genetics, development, evolution, ecology, and the origin of life. Each topic is considered in the light of modern evolutionary theory.

BIO S 103–104 Biological Sciences, Laboratory

103, fall; 104, spring. 2 credits each term. Prerequisite: concurrent enrollment in Biological Sciences 101 (fall) or 102 (spring). 103 is prerequisite to 104 unless written permission is obtained from instructor. S-U grades optional, with permission of instructor. No admittance after second week of classes.

Lab, M T W or R 1:25–4:25, M or W 7:30–10:30 p.m, or T R or S 8–11. One 3-hour lab each week and a weekly lec for discs, special lecs, etc. J. C. Glase, P. R. Ecklund, and staff.

Biological Sciences 103–104 is designed to give students laboratory experience with major biological phenomena in order to support an understanding of the important concepts, principles, and theories of modern biology. A second objective of the laboratory course is to help students gain expertise in the methods used by biologists to construct new knowledge. Students are exposed to basic concepts, research methods, including laboratory and data transformation techniques, and instrumentation in the major areas of biology. First-semester topics include biochemistry, physiology, plant biology, and behavior. In the second semester, laboratory experience is provided in the areas of genetics, biotechnology, development, organismal diversity, population genetics and growth, and ecology. During the first semester, dissection of a doubly-pithed frog is included. Pithing is done by the instructor.

BIO S 105–106 Introductory Biology
105, fall; 106, spring. 4 credits each term (or 2 credits, with permission of instructor). Enrollment limited to 200 students. Prerequisite: 105 is prerequisite to 106, unless written permission is obtained from instructor. S-U grades optional, with written permission of instructor. May not be taken for credit after Biological Sciences 101–104 or 109–110. No admittance after first week of classes. Fee, $5.

Lec, T 9:05 (1st lec of fall term, R 8/29 9:05); additional study and lab hours to be arranged. Staff.

Designed primarily for biology majors, preprofessionals, and other students who desire a challenging, broad introduction to fundamental concepts of biology. Physiology, anatomy (accompanied by preserved vertebrate dissection), and biochemistry are strongly emphasized in the fall semester. Subjects of study in the spring semester are genetics, development, ecology, evolution, behavior, and the diversity of organisms. The course uses an autotutorial format and offers considerable flexibility in scheduling. Completion of the course requires mastery of a group of core units. Testing on these units is primarily by oral examination. Four formal laboratory sessions are offered each semester. Written reports on experimental work are required in the fall; extensive dissections (both invertebrate and vertebrate) with practical exams constitute spring laboratories. The core units include additional laboratory work. Performance on the core units, the laboratories, and the final examination determine the final grade. Students who object to dissecting live invertebrates may want to take another biology course.

BIO S 107–108 General Biology
Summer (8-week session; 107, weeks 1–4; 108, weeks 5–8). 4 credits each. Prerequisite: Biological Sciences 101–103, 105, or 107 is a prerequisite for 108. Fee, $25 for weeks 1–4; $15 for weeks 5–8.

Lecs, M-R 9–12; labs, M T R 1:30–4:30, F 9–12. Staff.

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

BIO S 109–110 Biological Principles
109, fall; 110, spring. 3 credits each term. Limited to 600 students. Prerequisite: A passing grade in 109 or 101–103 or 105 is prerequisite to 110 unless written permission is obtained from the instructor and student has at least 3 credits of college biology. Letter grades only. May not be taken for credit after Biological Sciences 101–104 or 105–106. This course may be used to fulfill the distribution requirement in the Colleges of Agriculture and Life Sciences, Arts and Sciences, and Human Ecology but may *not* be used as an introductory course for the major in biological sciences. *Note that this course may not always satisfy the prerequisite for second- and third-level courses in biology.*

Lecs, M W F 9:05 or 10:10; lab, M T W R or F 2–4:25 or T 10:10–12:35. Students do not choose lab sections during course enrollment; lab assignments are made during first day of classes. Each student must attend lab on alternate weeks. Evening prelims: fall, Sept. 26 and Nov. 7; spring, Feb. 20 and Mar. 31. C. H. McFadden, C. Eberhard.

Students who do not plan to major in biology may take this broad introductory course in modern biology. It is not a course in social biology but addresses itself to biological principles with academic rigor. The content is designed to appeal to anyone who seeks a comprehensive knowledge of biology as part of a general education. Laboratory sections enable small groups of students to meet with the course staff and are used for problem-solving experiments, demonstrations, and discussions. No live dissections are involved; there are dissections of vertebrate and invertebrate material.

BIO S 152 Special Topics in Biology
Spring. 1 credit. Limited to 30 students. Prerequisites: superior performance in Biological Sciences 109 or equivalent and concurrent enrollment in Biological Sciences 102, 106, or 110, or written permission of instructor. S-U grades only. *This course may not be used in fulfillment of college distribution requirements.*

Lec, M 3:35: occasional field trips to be arranged. R. Turgeon, C. Eberhard, and guest lecturers.

A lecture course designed to complement introductory biology by providing an opportunity for deeper exploration of selected topics of interest. Class involvement and discussion are encouraged.

BIO S 200 Special Studies in Biology
Fall, spring, or summer. 1–3 credits. Prerequisites: transfer- or special-student status and written permission of instructor and of the associate director of the Division of Biological Sciences. Students must register using a special form available in Stimson 200. S-U grades optional, with permission of instructor.

Hours to be arranged. Staff.

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

BIO S 201 Biotechnology: The "New" Biology (also Biology and Society 201)
Spring. 3 credits. Prerequisite: One year of introductory biology for nonmajors. S-U grades optional.

Lecs, T R 2:30; disc, T or R 3:35 (students must reserve both days for special sessions). J. M. Fessenden MacDonald, J. M. Calvo, and staff.

Designed for nonmajors, a general introduction to the application of modern molecular biology and cell culture techniques to the manipulation and genetic engineering of animals, plants, and microorganisms. Information on recombinant DNA technology, monoclonal antibodies, plant and/or animal cell culture, and embryo manipulation methods is presented. Topics include environment, agriculture and food; and economic, social-policy, regulatory, ethical, and legal issues that surround biotechnology. The course is taught in four modules and the topics vary from year to year. Topics are listed in the division's catalog supplement issued at the beginning of the semester. Topics for 1992 are genetic screening, crop plant biotechnology, immunology and AIDS, and human reproductive biotechnology. Recommended for those students who want to understand some new research discoveries, their applications, and social, legal, and policy issues stemming from them.

[BIO S 202 History of Biology (also Biology and Society 288 and History 288)
Spring. 3 credits. Prerequisite: one year of introductory biology. S-U grades optional. Not offered 1991–92.

Lecs, T R 10:10–11:25. W. B. Provine.

An examination of the history of biology, emphasizing the interaction of biology and culture. Original writings of biologists constitute the bulk of reading assignments. Covers the period from classical antiquity to the present, but primary emphasis is on twentieth-century biology.]

BIO S 205 Ethics and Health Care (also Biology and Society 205 and Philosophy 245)
Fall and summer (6-week session). 4 credits. Limited to 80 students (25 under Biological Sciences 205, 25 under Biology and Society 205, and 30 under Philosophy 245). Registered students not attending during the first week will be dropped from the course. Open to sophomores, juniors, and seniors; permission of instructor required for graduate students.
Lecs, T R 2:55–4:10; disc, 1 hour each week to be arranged. D. Jamieson.
Critical *philosophical* analysis of the conceptual frameworks in which ethical problems associated with health care can be formulated and solutions evaluated. General topics (with sample issues in parentheses) include knowledge in ethics (ethical skepticism, ethical relativism); proper social allocation of resources for, and within, medicine (entitlement to health care, access to scarce medical resources, cost-benefit analysis); the proper account of basic concepts such as illness, death, autonomy, and personhood (abortion, euthanasia, procreative technologies); and the professional-patient relationship (informed consent, confidentiality, medical paternalism).

BIO S 206 Ethics and the Environment (also Biology and Society 206 and Philosophy 246)
Fall. 4 credits. Open to all undergraduates. Permission of instructor required for graduate students.
Lecs, T R 10:10–11.25. Next offered Spring 1993. Disc, 1 hour each week to be arranged. D. Jamieson.
Critical *philosophical* analysis of the conceptual frameworks in which policies affecting the environment are formulated and judged. An introductory section of the course discusses the nature of ethics and the possibility of knowledge in ethics. The first major substantive component of the course deals with the nature and extent of individual and social obligations to spatially distant people, future generations, nonhuman animals and nonsentient things (e.g., the ecosystem). The second major component of the course deals with the appropriate analysis of the origin of environmental problems and the range of options for their solution. Topics include individual vs. collective goods, cost-benefit analysis, and coordination problems.

BIO S 207 Evolution (also History 287)
Fall. 3 credits. Intended for students with no background in college biology. May not be taken for credit after Biological Sciences 378. S-U grades optional.
Lecs, T R 10:10; disc, to be arranged. J. I. Davis and staff.
Evolution is the central concept in biology. This course examines evolution in historical and cultural contexts. Aims of the course include understanding the major issues in the history and current status of evolutionary biology and exploring the implications of evolution for culture. Issues range from controversies over mechanisms of evolution in natural populations to the conflict between creationists and evolutionists.

BIO S 208 Drawing the Human Figure
Summer (6-week session). 3 credits.
Lab, M T W 3–5:15. K. Kucharski.
Human anatomy. Emphasis on learning correct anatomical information relating to the skeletal and muscular systems as approached through observation and drawing practices.

BIO S 209 Introduction to Natural Science Illustration
Summer (6-week session). 2 credits. Limited to 12 students. Prerequisite: free-hand drawing or permission of instructor. S-U grades optional.
Lec and lab, T R 6:30–9:30 p.m. B. S. King.
An introduction to the art of natural science illustration for publication, and to the techniques of various media including pencil, pen and ink, watercolor, colored pencil, scratchboard, and carbon dust. Potentials and limitations of line and half-tone reproduction, copyright, and portfolio presentation are discussed.

BIO S 301 Biology and Society: The Social Construction of Life (also Biology and Society 301)
Fall. 4 credits. Prerequisite: one year of introductory biology. S-U grades optional.
Sem and disc, M W 2:30–4:25. P. J. Taylor.
Controversial issues, past and present, in the life sciences and tools for analysis of the social, historical, and conceptual underpinnings of these issues. Topics include evolution and natural selection, heredity and genetic determinism, biotechnology and reproductive interventions, and ecology and environmental change. Analytic themes include bias, metaphor, historical semantics, styles of explanation, determinism, causality, interest, social construction, and mapping. Through discussions and writing exercises, students develop analytic skills and explore their own responses to current issues.

BIO S 400 Undergraduate Seminar in Biology
Fall or spring. Variable credit (1–3 credits assigned for individual seminar offerings). May be repeated for credit. S-U grades optional.
Sem to be arranged. Staff.
From time to time specialized seminars on topics of interest to undergraduates are offered by visiting faculty or faculty from the Sections of Ecology and Systematics, Genetics and Development, or Plant Biology. Topics and instructors are listed in the division's catalog supplement issued at the beginning of the semester. For students interested in Biochemistry, Physiology, or Neurobiology, please see descriptions under appropriate section.

BIO S 401 Introduction to Scanning Electron Microscopy
Fall or spring, weeks 1–8. 1 credit. Limited to 8 students (fall), 12 students (spring). Prerequisite: permission of instructor. S-U grades optional.
Lec, M 10:10; labs, T R or F 9:05–12:15 or T W or R 1:25–4:25. M. V. Parthasarathy.
A general introduction to the principles and the proper use of the scanning electron microscope. Emphasis is on biological material.

BIO S 403 Transmission Electron Microscopy for Biologists
Fall. 1, 2, or 3 credits. 3 credits if student takes both sections. Limited to 12 students. Prerequisites: Biological Sciences 313, 345, 443, or written permission of instructor. S-U grades optional.
Lec, T 11:15; labs, M W or T R 1:25–4:25. Two sections: Sec 01, 1 credit, weeks 1–4; sec 02, 2 credits, weeks 5–8. Students may register for one or both sections. M. V. Parthasarathy.
Section 01, 1 credit, weeks 1–4, covers the principles and use of the transmission electron microscopy (TEM), with emphasis on proper operation of the instrument and interpretation of images obtained. Negatively stained materials are used for viewing with the transmission electronmicroscope. Section 02, 2 credits, weeks 5–8, covers the principles and techniques of preparing biological material for transmission electron microscopy. Using animal, plant, and microbe materials this section studies chemical fixtures, cryofixations, ultrathin sectioning, and metal shadowing techniques. Students have two additional weeks to complete laboratory assignments at the end of each section.

BIO S 405 Electron Microscopy in Molecular Biology
Fall, weeks 9–12. 1 credit. Limited to 12 students. Prerequisites: Biological Sciences 403 or proficiency in transmission electron microscopy and written permission of instructor. S-U grades optional.
Lec, T 11:15; labs, M W or T R 1:25–4:25. M. V. Parthasarathy, M. Kyle.
An introductory course to electron microscopy (EM) for use as a tool in analyzing molecular structure, interactions, and processes. Methods considered to be most generally applicable to current studies in molecular biology are covered, including visualization of nucleic acids, heteroduplexes, protein molecules and filaments, and EM immunolabelling.

BIO S 407 Advanced Laboratory Techniques
Summer (special programs). 3 credits.
Labs, M–F 9–5. M. Kusch, B. Johnson.
Intensive laboratory course taught in three one-week modules, stressing techniques in molecular biology, cell biology and physiology, and neurobiology.

Students who take this course must be accepted into the Hughes Scholars Program offered during Summer Session. The program begins with an intensive three-and-one-half-week laboratory course. After the laboratory course, students spend the next seven weeks doing independent research in a Cornell biology laboratory. Students receive stipends of $2,300. Students are expected to continue their research projects by enrolling in Biological Sciences 499 and attending a one-credit fall and spring seminar course (Biological Sciences 400) during their senior year. Information about the program and applications are available from the Behrman Biology Center, 216 Stimson Hall, or from Meredith Kusch (255-9405). Application deadline is in mid-February each year.

[BIO S 469 Food, Agriculture, and Society (also Biology and Society 469)
Spring. 3 credits. Prerequisite: an introductory ecology course or permission of instructor. S-U grades optional. Possible fee for course reading materials. Not offered 1991–92.
Lecs, T R 1:25–2:40. A. G. Power.
A multidisciplinary course dealing with the social and environmental impact of food production in the United States and in developing countries. Agroecosystems of various kinds are analyzed from biological, economic, and social perspectives. The impacts of traditional, conventional, and alternative agricultural technologies are critically examined in the context of developed and developing economies. Specific topics include pest management, soil conservation, farm labor, land reform, biotechnology, and international food policy.]

BIO S 498 Teaching Experience
Fall or spring. 1–4 credits. Enrollment limited. Prerequisites: previous enrollment in the course to be taught or equivalent, and written permission of instructor. S-U grades optional, with permission of instructor. *Students in the College of Arts and Sciences may not count credits from this course toward the 120 credits required for graduation.*
Hours to be arranged. Staff.
Designed to give qualified undergraduate students teaching experience through actual involvement in planning and assisting in biology courses. This experience may include supervised participation in a discussion group, assisting in a biology laboratory, assisting in field biology, or tutoring. Biological sciences courses currently offering such experience include Biological Sciences 105–106, 231, 291, 292, 311, 319, 330, 430, and 475.

BIO S 499 Undergraduate Research in Biology
Fall or spring. Variable credit. *Students in the College of Arts and Sciences may not register for more than 6 credits per term with one supervisor or 8 credits per term with more than one supervisor.* Prerequisite: written permission of staff member who supervises the work and assigns the grade. Students must register in the Office for Academic Affairs in 200 Stimson. Each student must submit an independent study statement describing the proposed research project during course registration. (Special forms for this purpose are available in the college offices.) S-U grades optional. Any faculty member in the Division of Biological Sciences may act as a supervisor. Faculty supervisors outside the division are acceptable only if a faculty member of the division agrees to serve as cosigner, taking full responsibility for the quality of the work.
Hours to be arranged. Staff.
Practice in planning, conducting, and reporting independent laboratory and library research programs. Research credits may *not* be used in completion of the following programs of study: animal physiology and anatomy; biochemistry; botany; cell biology; ecology, and evolutionary biology; genetics and development; and microbiology. No more than 4 credits of research may be used in completion of the program of study in neurobiology and behavior.

BIO S 601 Evolution, Ecology, and Behavior
Summer (special programs). 3 credits.
Lecs, M–F 9–5; labs, M–F 1:30–4:30.
R. R. Hoy, W. Provine, J. Yavitt, and staff.
Lecture and laboratory course designed specifically for high school biology teachers. The lecture covers some aspects of evolution, behavior, and ecology. Field work in ecology is included which is designed to enable participants to lead their own classes in field exercises near their own high schools.

Cornell has received a three-year grant from the National Science Foundation Teacher Enhancement Program to upgrade the information and skills of high school biology teachers. Twenty teachers from a hundred-mile radius of Ithaca are chosen to participate each summer in a three-week intensive program at Cornell. A major part of the program is a lecture and laboratory course. In addition, there are field trips to various Cornell research facilities, guest lectures by Cornell faculty on their research interests, as well as discussions with faculty involved in teaching introductory biology. Teachers also perform laboratory exercises designed for high school biology classes. There is an important component providing teachers with instruction and practice in the use of computers directed toward enhancing teaching. Each selected participant will be provided with an Apple Macintosh computer on long-term loan.

BIO S 602 Molecular Biology for Teachers (formerly Biological Sciences 408)
Summer (special programs). 3 credits.
Lecs, M–F 9–5. R. Calvo, M. L. Cordts, and M. Colvard.
Lecture and laboratory course in molecular biology designed specifically for high school biology teachers. The lecture material covers the structure and biosynthesis of macromolecules, recombinant DNA technology, the unexpected complexity of eukaryotic genes, and the application of recombinant DNA technology to medicine and agriculture. The laboratories provide experience with techniques used in modern molecular biology. Registration limited to teachers selected to participate in the Cornell Institute for Biology Teachers.

Cornell has received a five-year grant from the Howard Hughes Medical Institute to upgrade the information and skills of high school biology teachers. Twenty teachers from a hundred-mile radius of Ithaca are chosen to participate each summer in a three-week intensive program at Cornell. A major part of the program is a lecture and laboratory course in molecular biology. Also included are field trips to various Cornell research facilities, guest lectures by Cornell faculty on their research interests, as well as discussions with university faculty involved in teaching introductory biology. Teachers also perform laboratory exercises designed for high school biology classes. To enable teachers to implement new laboratory exercises, the grant provides each teacher with up to $2,000 worth of equipment and supplies to take home to their biology classes plus an Apple MacIntosh computer on long-term loan. Participating teachers get 3 credits, board, and a stipend. Applicants should not apply directly to the Summer Session Office. More information on the program and the application process is available from Rita Calvo or Stephanie Henkel, Cornell/Hughes Program, 169 Biotechnology Building, 254-4831.

BIO S 606 Freeze-Fracture Technique
Spring, weeks 9–14. 1 credit. Primarily for graduate students. Limited to 8 students. Prerequisites: Biological Sciences 403 or equivalent, and permission of instructor. S-U grades only.
Lec, M 10:10; disc to be arranged; labs, M W 1:25–4:25. M. V. Parthasarathy.
Principles of freeze-fracturing and freeze-substitution technique, freezing artifacts, and interpretation of images.

BIO S 608 Advanced Electron Microscopy for Biologists
Spring, weeks 10–14. 1 credit. Primarily for graduate students. Limited to 6 students. Prerequisite: Biological Sciences 403 or equivalent. S-U grades only.
Hours to be arranged.
M. V. Parthasarathy.
Project in biological ultrastructure.

BIO S 702 X-Ray Elemental Analysis in Biology
Spring, weeks 7–14. 1 credit. Limited to 6 students. Prerequisites: Biological Sciences 403 or equivalent, and permission of instructor. S-U grades only. Offered alternate years.
Lec and lab to be arranged.
M. V. Parthasarathy, C. Daugherty.
Principles of X-ray elemental analysis are discussed, with special reference to the energy-dispersive system. Emphasis is on qualitative elemental analysis of biological specimens and preparation of material for such analysis, including freeze-substitution technique. A brief introduction to quantitative elemental analysis is also given.

Related Course in Other Departments

Medicine and Civilization (Biology and Society 322)

ANIMAL PHYSIOLOGY AND ANATOMY

[BIO S 214 Biological Basis of Sex Differences (also Biology and Society 214 and Women's Studies 214)
Fall. 3 credits. Prerequisite: one year of introductory biology. Limited to non-biology majors and freshman and sophomore biology majors. S-U grades optional. Offered alternate years. Not offered 1991–92.
Lecs, T R 8:30–9:55; occasional disc to be arranged. J. E. Fortune.
The structural and functional differences between the sexes are examined. Emphasis is placed on mechanisms of mammalian reproduction; where possible, special attention is given to studies of humans. Current evidence on the effects of gender on nonreproductive aspects of life (behavior, mental and physical capabilities) is discussed. The course is intended to provide students with a basic knowledge of reproductive endocrinology and with a basis for objective evaluation of sex differences in relation to contemporary life.]

BIO S 311 Introductory Animal Physiology, Lectures (also Veterinary Medicine 346)
Fall. 3 credits. Prerequisites: one year of college biology, chemistry, and mathematics. Recommended: previous or concurrent course in physics. S-U grades optional, with permission of instructor.
Lecs, M W F 8:00. Evening prelims: Sept. 24 and Oct. 31. E. R. Loew and staff.
A general course in animal physiology emphasizing principles of operation, regulation, and integration common to a broad range of living systems from the cellular to the organismal level. Structure/function relationships are stressed along with underlying physico-chemical mechanisms.

BIO S 313 Histology: The Biology of the Tissues
Fall. 4 credits. Prerequisite: one year of introductory biology. Recommended: background in vertebrate anatomy and organic chemistry or biochemistry.
Lecs, T R 1:25; labs, T R 2:30–5. R. B. Silver.
Provides students with a basis for understanding the microscopic, fine-structural, and functional organization of vertebrates, as well as methods of analytic morphology at the cell and tissue levels. Dynamic interrelations of structure, composition, and function in cells and tissues are emphasized. The course may include work with invertebrate or vertebrate animals.

BIO S 315 Topics in Functional Anatomy
Fall. 1 credit. Prerequisite: one year of college biology. Required of students studying animal physiology and anatomy.
Disc, one hour per week to be arranged. E. R. Loew, D. Robertshaw.
Comparative functional anatomy of both invertebrates and vertebrates is presented at the whole animal level using prepared and fresh materials. Correlations between structure, function, and ecological significance are stressed.

BIO S 316 Cellular Physiology
Spring. 4 credits. Limited to 100 students, with preference given to students studying in animal physiology and anatomy. Each lab limited to 24 students. Prerequisite: concurrent or previous enrollment in Biological Sciences 330 or 331.
Lecs, M W F 9:05; lab, M T W or R 1:25–5. A. Quaroni and staff.
Lectures introduce students to the most current information on the ways cells function and regulate themselves and neighboring cells and on what molecules are involved in these regulatory processes. Laboratories provide an introduction to cell and organ culture and to immunological techniques used to study cell structure and function *in vivo* and *in vitro*. Experiments performed in the laboratory are closely related to, and provide practical experience with, subjects covered in the lectures. Vertebrate animals are used in this course. No experimentation is performed on live animals.

BIO S 319 Animal Physiology Experimentation (also Veterinary Medicine 348)
Fall. 3 credits. Designed for upper-level undergraduate and graduate students studying in physiology, and other students interested in biomedically related professions. Each of 4 afternoon laboratory sections limited to 20 students. Prerequisite: concurrent or previous enrollment in Biological Sciences 311 or permission of instructor based on previous meritorious performance in another introductory animal physiology course.
Lab, M T W or R 1:25–5; disc, R or F 12:20. Students do not choose disc sections during course enrollment; disc assignments are made during first day of classes. R. A. Corradino, P. W. Concannon.
A series of student-conducted *in vitro* and *in vivo* experimental exercises designed to illustrate basic physiological processes in animals and to introduce students to animal physiology research techniques, instrumentation, experimental design, and interpretation of results. Techniques include anesthesia, dissection, vivisection under anesthesia, physiographic recording, use of radioisotopes, and computer analysis. Experiments with living tissues and live animals examine properties of blood, muscle, and nerves; cardiovascular, respiratory and gastrointestinal function and control; and endocrine regulation of mineral metabolism and reproductive tissue activity. Experimental resources include live animals of several vertebrate species, including frogs, birds, rats, and rabbits, which are euthanized in conjunction with the laboratory exercises. Written reports of laboratory activities are required. Grading is based on evaluation of these reports, quizzes, and laboratory performance.

BIO S 458 Mammalian Physiology
Spring. 3 credits. Enrollment limited. Graduate student auditors allowed. Prerequisite: Biological Sciences 311 or equivalent with permission of instructor.
Lecs, M W F 10:10. K. W. Beyenbach and staff.
An in-depth treatment of selected topics in mammalian physiology and human physiology. Emphasis is on a conceptual and working knowledge of physiology rather than a factual, memorizing knowledge. Topics selected, in order of presentation, include recurrent themes in physiology; basic functional elements of biological systems; design of multicellular animals; mammalian fluid compartments; homeostasis; cardiovascular, respiratory, gastro-intestinal, and renal physiology; and energy metabolism. The course concludes with a discussion of integrative physiology by considering the multiple, parallel short-term responses of the human body to exercise. Recommended for biological sciences majors, pre-med and pre-vet students, and beginning graduate students in physiology, nutrition, and animal science.

BIO S 615 Nutrition and Physiology of Mineral Elements (also Veterinary Medicine 759 and Nutritional Sciences 659)
Spring. 3 credits. Prerequisites: courses in basic physiology, intermediate biochemistry, and general nutrition. Offered alternate years.
Lecs, M W F 9:05. R. Schwartz, R. H. Wasserman, D. R. Van Campen, C. C. McCormick.
Lectures on nutritional aspects and physiological, biochemical, and hormonal relationships of the major macroelements and microelements, with emphasis on recent developments. Discussions of methodologies of mineral research and essentiality, transport, function, homeostasis, interrelationships, and toxicity of various mineral elements.

BIO S 618 Biological Membranes and Nutrient Transfer (also Veterinary Medicine 752)
Spring. 2 credits. Prerequisites: courses in animal or plant physiology, quantitative and organic chemistry, and physics. Recommended: a course in cellular physiology. S-U grades optional, with permission of instructor. Offered alternate years.
Lecs, T R 11:15. R. H. Wasserman.
An introduction to elementary biophysical properties of biological membranes; theoretical aspects of permeability and transport; mechanism of transfer of inorganic and organic substances primarily across epithelial membranes; and characteristics and properties of transporting macromolecules and ion channels.

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

BIO S 658 Molecular Mechanisms of Hormone Action (also Veterinary Medicine 758)
Spring. 2 credits. Prerequisite: permission of instructor. Minimum enrollment of 6 required. Offered alternate years.
Lecs, T R 10:10. R. A. Corradino.
An advanced course developed from the current literature on endocrine mechanisms.

BIO S 711–718 Special Topics in Physiology
Fall or spring. 1 or 2 credits for each topic. May be repeated for credit. Enrollment in each topic may be limited. S-U grades optional, with permission of instructor. Lectures, laboratories, discussions, and seminars on specialized topics.

Fall 1991: four topics are offered.

BIO S 711 The Physiological Systems That Control Ingestive Behavior: Thirst and Hunger
1 credit. Offered alternate years.
Lec, 1 hour each week to be arranged. T. R. Houpt.
Common mammalian species are considered: rat, dog, goat, pig, horse, and human.

BIO S 713 Thermoregulation and Exercise
1 credit. Offered alternate years.
Lec, 1 hour each week to be arranged. D. Robertshaw.

An examination of the competing demands on the body of exercise and heat exposure with particular emphasis on the cardiopulmonary system and integration of thermoregulatory reflexes.

BIO S 715 Acid-Base Relations (also Veterinary Medicine 627)
2 credits.
Autotutorial. A. Dobson.

BIO S 717 Proteolysis in Physiological Function and Dysfunction (also Biological Sciences 737)
1 credit.
Lec, 1 hour each week to be arranged. J. F. Wooton.

Spring 1992: three topics are offered.

BIO S 712 Plasma Lipoproteins
1 credit.
Sem, one hour each week, to be arranged. A. Bensadoun.

BIO S 715 Acid-Base Relations (also Veterinary Medicine 627)
2 credits.
Autotutorial. A. Dobson.

BIO S 718 Evolution of Color
1 credit. Offered alternate years.
Lec, one hour each week to be arranged. E. R. Loew.

BIO S 719 Graduate Research in Animal Physiology (also Veterinary Medicine 628)
Fall or spring. Variable credit. Prerequisites: written permission of the section chair and of the staff member who supervises the work and assigns the grade. Students must register in Vet Research Tower 725. S-U grades optional.
Hours to be arranged. Staff.
Similar to Biological Sciences 499 but intended for graduate students who are working with faculty members on an individual basis.

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

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

Related Courses in Other Departments

Adaptations of Marine Organisms (Biological Sciences 413)

Advanced Work in Animal Parasitology (Veterinary Medicine 737)

Animal Development (Veterinary Medicine 507)

Animal Reproduction and Development (Animal Science 300)

Developmental Biology (Biological Sciences 385)

Embryology (Biological Sciences 389)

Fundamentals of Endocrinology (Animal Science 427)

Insect Morphology (Entomology 322)

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

Neuroanatomy (Veterinary Medicine 504)

Sensory Function (Biological Sciences 492)

Teaching Experience (Biological Sciences 498)

Undergraduate Research in Biology (Biological Sciences 499)

BIOCHEMISTRY, MOLECULAR AND CELL BIOLOGY

BIO S 132 Orientation Lectures in Biochemistry
Spring, weeks 1–3. No credit. Primarily for freshmen, sophomores, and transfer students. S-U grades only (registered students receive an unsatisfactory grade for nonattendance).
Lec, S 10:10–11:00, for first 3 S of semester. Section chair and staff.
Discussions by six professors about their research and promising areas for research in the future.

BIO S 231 General Biochemistry
Fall. 3 credits. Intended for students who have not studied biochemistry previously and who do not expect to pursue it further. Not recommended for students who have taken organic chemistry. Prerequisite: Chemistry 104 or 208 or equivalent. S-U grades optional.
Lecs, M W F 12:20. J. M. Griffiths.
A brief introductory section relating organic chemistry to biochemistry is given, followed by the biochemical material in the usual one-semester introductory courses. Topics of general interest are also included.

BIO S 232 Recombinant DNA Technology and Its Applications (also Biology and Society 232)
Spring. 3 credits. S-U grades optional. Limited to freshmen with AP 4 or 5 in biology. Possible fee for course material.
Lecs and disc, M W F 11:15. J. M. Calvo, J. M. Fessenden MacDonald.
An introduction to molecular approaches to biology. Basic concepts underlying recombinant DNA technology together with strategies for cloning genes are discussed. Much of the course deals with applications of recombinant DNA technology to basic research and to biotechnology. Applications to be discussed include screening for genetic diseases, animal and plant improvement, and production of proteins useful in medicine, agriculture, and industry. Scientific, historical, regulatory, social, and ethical issues are presented and discussed. Recommended especially for students desiring a firm background in recombinant DNA technology in preparation for taking genetics and biochemistry.

BIO S 330–331 Principles of Biochemistry
Introductory biochemistry is offered in two formats: individualized instruction (330) and lectures (331). *Individualized instruction is offered to a maximum of approximately 150 students each semester. Lectures given fall semester only.*

BIO S 330 Principles of Biochemistry, Individualized Instruction
Fall or spring. 4 credits (2 credits if taken after Biological Sciences 231). Prerequisite: Chemistry 253 or 358 or equivalent. May not be taken for credit after Biological Sciences 331. S-U grades optional for graduate students only.
Evening prelims: fall, Oct. 24; spring, Mar. 10. M. F. Ferger, R. Wu, P. C. Hinkle.
The core material of the course includes protein structure and function, enzymes, basic metabolic pathways, DNA, RNA, protein synthesis, and an introduction to gene cloning. There are no formal lectures; the course has an autotutorial format. The core material is divided into fourteen units of work that are outlined in a study guide written to accompany the textbook. Students prepare the work on their own, with help from the staff of the Study Center if desired, and must pass a written and an oral quiz on each unit. A final exam is required.

Each student also participates in six class hours of discussions on research papers and must submit a certain number of problems during the semester.

BIO S 331 Principles of Biochemistry, Lectures
Fall or summer. (6–week session). 4 credits (or 2 credits if taken after Biological Sciences 231). Enrollment may be limited to 400 students in fall. Prerequisite: Chemistry 253 or 358 or equivalent. May not be taken for credit after Biological Sciences 330. S-U grades optional for graduate students only.
Lecs, M W F S 10:10. G. W. Feigenson, R. Barker, B.-K. Tye.
Chemistry of biological substances presented in lecture format. Course content is similar to that of Biological Sciences 330.

BIO S 430 Basic Biochemical Methods
Fall or spring. 4 credits. Enrollment limited. Prerequisites: Biological Sciences 330 or 331, organic chemistry lectures and laboratory, and permission of instructor obtained by preregistering in Wing 312. Concurrent registration in Biological Sciences 330 or 331 may be arranged in the fall term for graduate students.
Lec and disc, F 1:25; labs, M W or T R 12:20–4:25. R. R. Alexander, J. M. Griffiths, and staff.
A laboratory course designed to introduce students to the biochemical techniques commonly used in the study of biological materials. Students work in small groups, and each student may select two of three or four modules offered. Various assay methods, chromatography, electrophoresis, and use of the scintillation counter are taught. Protein isolation, purification, and enzyme characterization methods are included. Techniques used in the clinical laboratory are applied to analyses of blood and urine samples, and some nutritional analyses are done for protein and vitamin contents of foods. In the nucleic acids module, students are introduced to recombinant DNA methodology, isolating DNA, and studying the function of transfer RNA. A student may isolate and purify the lipids from a material of his/her choice and perform thin-layer chromatography and carry out cholesterol and phosphate analyses. Separation techniques are used to isolate cell components and experiments are conducted to illustrate basic biochemical methods.

BIO S 432 Survey of Cell Biology
Spring. 3 credits. Prerequisite: Biological Sciences 330 or 331 or equivalent. S-U grades optional for graduate students only.
Lecs, M W F 11:15. W. J. Brown and staff.
A survey of a wide array of topics focusing on the general properties of eucaryotic cells. The topics include methods used for studying cells, the structure and function of the major cellular organelles, and analyses of cellular processes such as mitosis, endocytosis, cell motility, secretion, cell-to-cell communication, gene expression, and oncogenesis. Some of the material is covered in greater depth in Biological Sciences 437, 483, 632, 636, and 639.

BIO S 433 Molecular Biology
Fall. 2 credits. Prerequisite: Biological Sciences 281 and 330 or 331.
Lecs, T R 11:15. T. C. Huffaker.
A comprehensive examination of the molecular biology of prokaryotic and eukaryotic cells. Topics include DNA and chromatin structure; genomic organization; replication, recombination, mutability, and repair of DNA; synthesis and processing of RNA and protein; and regulation of gene expression. The principles of recombinant DNA technology are discussed.

[BIO S 434 Biotechnology: Science, Policy, and Values (also Biology and Society 434)
Spring. 3 credits. Limited to 16 seniors and graduate students. Prerequisites: a course dealing with the science behind biotechnology or Biological Sciences 281 or 330 or 331 or permission of instructor. Fee for course materials. Not offered 1991–92.
Sem, M 2–4:25. J. M. Fessenden MacDonald.
Issues raised by the introduction of new biotechnology products and procedures to health care, food and agriculture, environment, and the legal system are analyzed. The course examines the scientific, political, legal, economic, social, and ethical implications of these issues. Cases studied vary each term. Readings from various disciplines including scientific papers, government reports, and industrial and legal reports provide background for class discussions. A research paper and oral presentations are required. Topic for spring 1993 is environment, agriculture, and food biotechnology. Topics for spring 1994 are DNA diagnostics, DNA screening, gene therapy, and DNA fingerprinting.]

BIO S 435–436 Undergraduate Biochemistry Seminar
435, fall; 436, spring. 1 credit each term. May be repeated for credit. Limited to upperclass students. Prerequisite: Biological Sciences 330 or 331 or written permission of instructor. S-U grades only.
Sem to be arranged. Organizational meeting first W of each semester at 4 p.m. Fall: G. P. Hess; spring: Staff.
Selected papers from the literature on a given topic are evaluated critically during six or seven two-hour meetings.

BIO S 437 Oncogenes and Cancer Viruses (formerly Biological Sciences 438 Cell Proliferation and Oncogenic Viruses)
Fall. 3 credits. Prerequisite: Biological Sciences 330 or 331. Recommended: Biological Sciences 281.
Lecs, T R 12:20–1:35. D. I. Shalloway.
A description of the growth properties of animal cells in culture, followed by discussions of the changes in cells that are induced by tumor viruses and oncogenes. Topics include immortalization of cells, the cell cycle, differences between normal and neoplastically transformed cells, macromolecular growth factors, transcription and translation of retrovirus genes, and structure and function of viral and cellular *onc* genes. An understanding of relevant experimental techniques is emphasized.

BIO S 630 Laboratory in Cell Biology
Spring. 4 credits. Enrollment limited. Prerequisites: a course in biochemistry or cell biology, and permission of instructor obtained by registering in 258 Biotechnology Building with J. Gibson.
Labs, M W 1:25–4:25 or R 9:05–4:25; disc to be arranged. J. Gibson, B. Tyler.
The course emphasizes approaches to experimental design and theory of experimental techniques as well as providing experience in handling and experimenting with cells of different kinds. Limited numbers of vertebrate animals are used for two experiments where no alternative approach exists.

BIO S 631 Protein Structure and Function
Fall. 3 credits. Prerequisites: introductory biochemistry, physical chemistry, and organic chemistry. S-U grades optional.
Lecs, M W F 9:05. P. A. Karplus.
Lectures on the principles of protein structure and the nature of enzymatic catalysis.

BIO S 632 Membranes and Bioenergetics
Spring. 2 credits. Prerequisite: Biological Sciences 330 or 331 or equivalent. Offered alternate years.
Lecs, T R 11:15. P. C. Hinkle.
Structure and dynamics of biological membranes, physical methods, model membranes, ionophores, ion-transport ATPases, mitochondrial and chloroplast electron transfer chains, and examples of transport from plants, animals, and bacteria.

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

[BIO S 635 Enzymes, Coenzymes, and Metabolic Regulation (also Nutritional Sciences 635) (formerly Mechanisms of Metabolic Regulation)
Spring. 2 credits. Prerequisites: Biological Sciences 330 or 331 and either Chemistry 358 or 360, or permission of instructor. Offered alternate years. Not offered 1991–92.
Lecs, T R 9:05. M. N. Kazarinoff.
Lectures on the identification and characterization of regulatory steps in metabolism, considered from both theoretical and practical aspects. The intracellular mechanisms of regulation are emphasized, with specific examples in mammalian metabolism examined in detail.]

BIO S 636 Current Topics in Cell Biology
Spring. 2 credits. Prerequisites: Biological Sciences 330 or 331, and 432, or their equivalents.
Lecs, T R 10:10. A. P. Bretscher.
Lectures covering current topics in cell biology, including a detailed discussion of secretion, endocytosis, membrane-bound organelles, membrane recycling, the cytoskeleton, cell motility, junctions, the cell cycle, and related topics. Together with Biological Sciences 632 and 639, this course provides broad coverage of the cell biology subject area.

BIO S 637 Integration and Coordination of Energy Metabolism (also Nutritional Sciences 636)
Fall. 3 credits. Prerequisite: Biological Sciences 330 or 331 or equivalent.
Lecs, M W F 9:05. Evening prelims to be arranged. W. J. Arion.
The elements and dynamics of energy metabolism in higher animals are developed systematically through biochemical characterizations of the metabolic components and structure of major tissues and organs. Emphasis is placed on correlations with physiologic functions. Mechanisms that control energy metabolism within individual tissues and coordinate these processes in intact animals are analyzed in the contexts of selected physiologic and pathologic stresses.

BIO S 638 Intermediate Biochemical Methods
Fall or spring. 4 credits. Primarily for graduate students minoring in biochemistry and undergraduates in the biochemistry program of study. Enrollment limited to 24 students in the fall and 48 students in the spring. Admission to the course is dependent upon the results of a personal interview with the teaching support specialist (x5-8072 or x5-5706), which must be held before the first day of classes. *There is no admission to the course without the interview.* Undergraduates are urged to interview during preregistration. May not be taken for credit after Biological Sciences 430.
Lab, T 9:05–4:25 (fall); lab, T or R 9:05–4:25 (spring). D. B. Wilson and staff.
Selected experiments on proteins, enzymes, DNA, and bioenergetics to illustrate basic biochemical properties. The course emphasizes quantitative aspects and techniques currently used in biochemical research.

BIO S 639 The Nucleus
Spring. 2 credits. Prerequisite: Biological Sciences 330 or 331 or equivalent. Recommended: Biological Sciences 281.
Lec, M 8–9:55 p.m. J. T. Lis.
Lectures on topics of eucaryotic gene organization, regulation of gene expression, RNA processing, chromatin structure, the structure and movement of chromosomes, and the architecture of the nucleus. This course and Biological Sciences 632 and 636 provide broad coverage of the cell biology subject area.

[BIO S 648 Plant Biochemistry
Spring. 3 credits. Prerequisites: organic chemistry, biochemistry, and a course in plant physiology. Offered alternate years. Not offered 1991–92.
Lecs, M W F 9:05. A. T. Jagendorf, J. F. Thompson.
Selected areas of plant biochemistry are reviewed in the context of the plant life cycle and responses to the environment. Topics include metabolism of lipids, carbohydrates, organic acids, and proteins; nitrogen and sulfur assimilation; respiration; photosynthesis; development and replication of chloroplasts; and cell-wall composition and properties. Attention is paid to operation of control mechanisms.]

BIO S 732–737 Current Topics in Biochemistry
Fall or spring. 1/2 or 1 credit for each topic. May be repeated for credit. Prerequisite: Biological Sciences 330 or 331 or equivalent. S-U grades only.
Lectures and seminars on specialized topics.

Fall 1991: two topics are offered.

BIO S 735 Current Topics in Biochemistry
1/2 credit.
Lec to be arranged (6 lecs). D. B. Stern.

BIO S 737 Proteolysis in Physiological Function and Dysfunction (also Biological Sciences 717)
1 credit.
Lec, 1 hour each week to be arranged. J. F. Wooton.

Spring 1992: topics to be announced in the division's course supplement published at the beginning of the spring semester.

BIO S 751 Ethical Issues and Professional Responsibilities
Fall or spring. 1 credit. Limited to 12 graduate students per section. S-U grades only.
Sem to be arranged. Section 01: for biologists. Organizational meeting W, Sept. 4, 3:35 p.m.; Section 02: for toxicologists. Organizational meeting F, Aug. 30, 1:25 p.m. J. M. Fessenden MacDonald.
Ethical issues in research and the professional responsibilities of scientists are discussed. Readings from scientific, ethics, and general papers and government reports provide background for discussion. Topics to be discussed include data manipulation and misrepresentation, fraud and misconduct, conflicts of interest and commitment, authorship, ownership, peer review, scientific response to external pressure, legal liabilities, and professional codes of ethics.

BIO S 755 Biotechnology Transfer
Fall or spring. 1 credit. S-U grades only.
Sem to be arranged. D. B. Wilson, J. M. Fessenden MacDonald.
Lectures and discussions on technology transfer and research in non-academic settings by speakers from industry, government, and academe. Focus is on opportunities for technology transfer and research in areas of biotechnology (agricultural, food, environment, pharmaceutical), biochemistry, bioengineering, and chemistry.

BIO S 830 Biochemistry Seminar
Fall or spring. No credit.
Sem, F 4:30. Staff.
Lectures on current research in biochemistry, presented by distinguished visitors and staff members.

BIO S 831 Advanced Biochemical Methods I
Fall. 6 credits. Limited to graduate students majoring in biochemistry. S-U grades optional.
Labs and discs, 12 hours each week to be arranged. Organizational meeting first R of semester at 10:10. B. Tyler and staff.
To learn the basic concepts and approaches to biochemical research, students participate in discussions and perform experiments on proteins, enzymes, DNA, and cell biology experiments of their choice. First half of the fall term is an intensive, structured course. Letter grades are assigned for this laboratory portion of the course. Second half of the fall term is devoted to a rotation project in different labs selected by the students. S-U grades only are assigned for the rotation portion of the course.

BIO S 832 Advanced Biochemical Methods II
Spring. 6 credits. Limited to graduate students majoring in biochemistry. S-U grades only.
Lab to be arranged. Staff (coordinator: graduate field representative).
Research in the laboratories of two or three different professors chosen by the student. Arrangements are made jointly between the graduate field representative and the research adviser.

BIO S 833 Research Seminar in Biochemistry
Fall and spring. 1 credit each term. (Students must register for 2 credits each term, since an "R" grade is given at the end of the fall term.) May be repeated for credit. Required of, and limited to, second-, third-, and fourth-year graduate students majoring in biochemistry. S-U grades only.
Sem, T 5–6:30 p.m. T. C. Huffaker, W. J. Brown, J. T. Lis.
Each student presents one seminar per year on his or her thesis research and then meets with instructors and thesis committee members for evaluation.

BIO S 835 Methods and Logic in Biochemistry, Molecular and Cell Biology
Fall and spring. 1 credit each term. (Students must register for 2 credits each term, since an "R" grade is given at the end of the fall term.) Limited to first-year graduate students majoring in the Field of Biochemistry, Molecular and Cell Biology. S-U grades only.
Sem and disc to be arranged. T. C. Huffaker, P. A. Karplus.
A seminar course with critical discussion by students of original research papers. A variety of topics in biochemistry, molecular and cell biology are covered.

Related Courses in Other Departments

Lipids (Biological Sciences 619 and Nutritional Sciences 602)

Molecular Aspects of Development (Biological Sciences 483)

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

Teaching Experience (Biological Sciences 498)

Undergraduate Research in Biology (Biological Sciences 499)

BOTANY

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

BIO S 242 Plant Physiology, Lectures
Spring. 3 credits. Primarily for undergraduates in agricultural sciences, but also for any Biological Sciences students wanting to know about how plants function. Suitable as a second-level course for nonmajors to satisfy the biology distribution requirement. Prerequisites: one year of introductory biology and introductory chemistry. Concurrent enrollment in Biological Sciences 244 required of undergraduates. May not be taken for credit after Biological Sciences 341 except by written permission of instructor.
Lecs, M W F 10:10. P. J. Davies.
How plants function and grow. Examples deal with crop plants or higher plants where possible, though not exclusively. Topics include cell structure and function; plant metabolism, including photosynthesis; light relations in crops; plant-water relations; water uptake, transport, and transpiration; irrigation of crops; sugar transport; mineral nutrition; growth and development—hormones, flowering, fruiting, dormancy, and abscission; stress; tissue culture; and genetic engineering.

[BIO S 243 Taxonomy of Cultivated Plants
Fall. 4 credits. Prerequisite: one year of introductory biology or written permission of instructor. May not be taken for credit after Biological Sciences 248. Not offered 1991–92.
Lecs, M W 10:10; labs, M W 2–4:25. M. A. Luckow.
A study of ferns and seed plants, their relationships, and their classification into families and genera, emphasizing cultivated plants. Particular emphasis is placed on gaining proficiency in identifying and distinguishing families and in preparing and using analytic keys. Attention is also given to the economic importance of taxa, to the basic taxonomic literature, and to the elements of nomenclature.]

BIO S 244 Plant Physiology, Laboratory
Spring. 2 credits. Prerequisite: concurrent enrollment in Biological Sciences 242. May not be taken for credit after Biological Sciences 349.
Disc and lab, M T W or R 12:20–4:25. C. Reiss.
Experiments exemplify concepts covered in Biological Sciences 242 and offer experience in a variety of biological and biochemical techniques, including use of small amounts of radioisotopes.

BIO S 245 Plant Biology
Summer (6-week session). 3 credits. Limited to 24 students.
Lecs, M–F 11:30–12:45; labs, M W 1:45–3:45. S. Williams.
Introductory botany, including plant identification. Emphasizes structure, reproduction, and classification of angiosperms. Seventy-five percent of the laboratory work is conducted outdoors in an area that surpasses most biological stations. Those who lack college-level biology are expected to work more closely with the instructor on supplemental instructional materials.

[BIO S 246 Plants and Civilization
Spring. 3 credits. Not offered 1991–92.
Lecs, T R 11:15; disc, T or W 1:25 or W or R 12:20. D. M. Bates.
A consideration of the role that plants have played and continue to play in the evolution of human cultures. Emphasis is on the interactions between humans and the plant environment, the nature of plants and manner in which humans use and integrate them into their cultures, and the problems and concerns related to contemporary and future use of plant resources.]

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

BIO S 341 Plant Physiology, Lectures
Fall. 3 credits. Prerequisites: one year of introductory biology, organic chemistry, and either concurrent enrollment in Biological Sciences 349 or written permission of instructor. May not be taken for credit after Biological Sciences 242 unless written permission is obtained from instructor.
Lecs, T R 10:10–11:25. Staff.
The behavior, growth, transport processes, and environmental response of plants. Topics include membrane properties, solute and water transport, and function of osmotic forces; mineral and organic nutrition; stress resistance; growth and development controls; metabolism, including photosynthesis and respiration; and responses to environmental influences.

BIO S 345 Plant Anatomy
Fall. 4 credits. Limited to 25 students. Prerequisite: one year of introductory biology or a semester of botany. Offered alternate years.
Lecs, M W 9:05; labs, M W 2–4:25. D. J. Paolillo.
A descriptive course with equal emphasis on development and mature structure. Lecture, laboratory, and reading are integrated in a study guide. The laboratory offers the opportunity to develop the practical skills required to make anatomical diagnoses and to write anatomical descriptions.

BIO S 346 Algal Physiology
Fall. 3 credits. Prerequisites: one year of introductory biology for majors and Biological Sciences 242 or 341, or permission of instructor. S-U grades optional. Offered alternate years.
Lecs, T R 8:30–9:55. T. G. Owens.
A brief description of the algal classes, as well as classical and emerging criteria for taxonomic classification. Discussions include the interactions of algae with their physical and chemical environments, uptake of inorganic compounds, algal photosynthesis, and metabolic strategies of unicellular and macrophytic algae. Emphasis is placed upon physiological comparisons between algae and higher plants.

BIO S 349 Plant Physiology, Laboratory
Fall. 2 credits. Prerequisite: concurrent enrollment in Biological Sciences 341. May not be taken for credit after Biological Sciences 244.
Lab, W 1:25–4:25; disc, W 12:20. C. Reiss.
Experiments exemplify concepts covered in Biological Sciences 341 and offer experience in a variety of biological and biochemical techniques, including use of small amounts of radioisotopes.

[BIO S 359 Biology of Grasses
Fall. 3 credits. Limited to 24 students. Prerequisite: one year of introductory biology or an introductory plant taxonomy course, or permission of instructor. S-U grades optional. Offered alternate years. Not offered 1991–92.
Lecs, T R 10:10; lab,T 1:25–4:25. J. I. Davis.
Systematics and ecology of the graminoid plant families (grasses, sedges, and rushes), with principal emphasis on grasses. Major topics include taxonomy, phylogenetics, physiology, reproductive biology, ecotypic variation, speciation, biogeography, and population biology. The role of graminoids as ecosystem dominants, weeds, and the origins of cultivated species are discussed. Laboratory concentrates on the diversity of grasses.]

[BIO S 440 Plant Geography
Spring. 2 credits. Prerequisite: Biological Sciences 248 or equivalent. Recommended: Biological Sciences 378 or 463 or both. S-U grades optional, with permission of instructor. Offered alternate years. Not offered 1991–92.
Lecs, T R 10:10. Bailey Hortorium staff.
Patterns of distribution and variation of plant species and higher taxa, endemism and disjunction and their causes, influences of past continental movements and climatic change on plant distributions, geographical aspects of plant speciation, major biomes and floristic regions of the world, and methods of phytogeographic analysis.]

[BIO S 441 Crop Plant Evolution
Fall. 2 credits. Prerequisite: an advanced-level course in the plant sciences with taxonomic content or permission of instructor. Offered alternate years. Not offered 1991–92.
Lecs, T R 11:15. D. M. Bates.
An integrated study of the systematics and evolution of agronomic and horticultural species. Processes of domestication, the evolutionary history of selected cultigens, the nature of weeds and land races, classification and nomenclature as applied to cultivated plants, and underexploited plant resources are among the topics considered.]

[BIO S 442 Biology of Plant Species
Spring. 2 credits. Prerequisite: Biological Sciences 248 or equivalent. Recommended: Biological Sciences 378 and 463. S-U grades optional, with permission of instructor. Offered alternate years. Not offered 1991–92.
Lecs, T R 10:10. Bailey Hortorium staff.
A comprehensive introduction to the nature and origin of plant species, with coverage of plant evolutionary genetics, race formation and modes of speciation, evolution of reproductive isolating mechanisms, types of species complexes found in plants, cytogenetic aspects of plant speciation, natural hybridization and its consequences, and the origin and nature of higher taxa.]

[BIO S 443 Research Methods in Systematic Botany
Fall. 2 credits. Limited to 10 students. Prerequisite: Biological Sciences 248 or equivalent. Offered alternate years. Not offered 1991–92.
Lab, F 1:25–4:25; additional hours to be arranged. Bailey Hortorium staff.
An introduction to the methodology of plant systematic research: field studies; sampling and collecting methods; preparation of taxonomic revisions and monographs; numerical methods of data analysis; and laboratory methods in cytogenetics, comparative anatomy, and comparative chemistry, as applied to problems in plant systematics.]

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

[BIO S 445 Photosynthesis (also Applied and Engineering Physics 601)
Fall. 3 credits. Prerequisites: Chemistry 104 or 208, Mathematics 105 or 111, and either Physics 102 or 208 or permission of instructor. Offered alternate years. Not offered 1991–92.
Lecs, M W F 10:10. T. G. Owens.
A detailed study of the processes by which plants utilize light energy to grow. Structure of the photosynthetic apparatus, light absorption and antenna processes, photochemistry, and electron transport are emphasized. The course incorporates biophysical, biochemical, physiological, and molecular aspects of photosynthesis. Photosynthetic carbon metabolism is not covered in detail. Discussions include relevant material in bacterial, algal, and higher-plant photosynthesis.]

[BIO S 446 Plant Cytogenetics
Fall. 3 credits. Limited to 18 students. Prerequisite: Biological Sciences 281 or equivalent. S-U grades optional. Offered alternate years. Not offered 1991–92.
Lecs, M W 9:05; lab, R 2–4:25. J. I. Davis.
An analysis of the cellular mechanisms of heredity, particularly the behavior of chromosomes, and the role of chromosome structure and behavior in plant evolutionary processes. The application of chromosomal studies to analyses of plant species biology and phylogenetics is also covered.]

BIO S 447 Molecular Plant Systematics
Fall. 3 credits. Prerequisites: Biological Sciences 248, 281, and 330 or 331, or written permission of instructor. Offered alternate years.
Lecs, T R 10 :10–11: 30. J. J. Doyle.
The study of variation at the molecular level and its application to the taxonomy and evolution of plants, particularly angiosperms. Emphasis is on the use of molecular evidence, particularly DNA data, for reconstructing phylogenies. Theory and methods of phylogenetic reconstruction are discussed. The organization and evolution of nuclear, mitochondrial, and chloroplast genomes, genes, and gene products are described from the standpoint of their utility for addressing a diversity of evolutionary questions. These questions span the entire taxonomic spectrum, and include such issues as the origin of angiosperms, evolution of species related to important crop plants, and population studies of hybridization.

[BIO S 448 Plant Evolution and the Fossil Record
Spring. 3 credits. Prerequisite: Biological Sciences 241 or equivalent, or permission of instructor. Offered alternate years. Not offered 1991–92.
Lecs, T R 9:05; lab, R 12:20–2:15. K. J. Niklas.
An introduction to evolution, surveying major changes in plants from the origin of life to the present. Emphasis is placed on plant form and function, adaptations to particular ecologic settings, and evolutionary theory as it relates to plants.]

BIO S 450 Optical Methods of Biologists
Spring. 3 credits. Limited to 12 students. Prerequisite: Introductory biology and permission of instructor.
Lecs, T R 1:25; lab, R 2:15–4:30. R. O. Wayne.
Theoretical and practical aspects of light microscopy, including brightfield, darkfield, phase-contrast, polarization, differential-interference-contrast, and fluorescence microscopy, as well as video- and computer-based digital image enhancement, are studied. Students learn both qualitative and quantitative techniques to probe noninvasively the structure and function of living plant cells.

BIO S 640 Applied Plant Anatomy
Spring. 3 credits. Prerequisites: Biological Sciences 345 or equivalent, and permission of instructor.
Lecs and discs, T R 9:05; lab, W 10:10–1:10 or by arrangement with instructor. Bailey Hortorium staff.
The use of anatomy in vascular plants for diagnosis of structure, taxonomic relationships, evolutionary sequences, and ecological adaptions, with emphasis on recent research. The laboratory provides experience in techniques and interpretation.

BIO S 641 Laboratory in Plant Molecular Biology
Spring. 4 credits. Prerequisites: Biological Sciences 281 or equivalent, 330 or 331 or equivalent, and permission of instructor. S-U grades optional.
Lab, T 9:05–4:30. J. B. Nasrallah, M. R. Hanson, S. D. Tanksley, P. F. Palukaitis.
Selected experiments on genome organization, gene expression, and gene transfer in plants. The course emphasizes the application of molecular biology methodology to plant systems. Students may have additional lab time to complete assignments.

[BIO S 642 Plant Mineral Nutrition (also Soil, Crop, and Atmospheric Sciences 642)
Spring. 3 credits. Prerequisite: Biological Sciences 341 or equivalent. Offered alternate years. Not offered 1991–92.
Lecs, M W F 10:10. L. V. Kochian, R. M. Welch.
A detailed study of the processes by which plants acquire and use mineral nutrients from the soil. Topics include the uptake, translocation, and compartmentation of mineral elements; root-soil interactions; the metabolism of mineral elements; the involvement of mineral nutrients in various physiological processes; and the nutrition of plants adapted to extreme environmental stresses (e.g., acid soils). Specific mineral elements are emphasized to illustrate these topics.]

BIO S 643 Plant Physiology, Advanced Laboratory Techniques
Fall. 4 credits. Prerequisites: organic chemistry, biochemistry, and a course in plant physiology. S-U grades only.
Lab, T or W 8–5; disc, M 4:30–5:30. A. T. Jagendorf.
An introduction to some modern methods in experimental plant biology. A partial list of techniques used includes radioactivity measurements, infrared CO_2 analysis, gel electrophoresis and Western Blots, cellular electrode measurements, microtiter plate technology for enzyme assays, sensitive growth measurements, HPLC and GC-MS, and computer interfacing with laboratory equipment.

BIO S 644 Plant Growth and Development
Spring. 3 credits. Prerequisites: Biological Sciences 345 and either 242 or 341 or their equivalents, or written permission of instructor. Offered alternate years.
Lecs, M W F 9:05. P. J. Davies, D. J. Paolillo.
Explores the changes that occur during plant growth and development and their control: morphological and anatomical changes in apices, tissue differentiation, organ formation, embryo development, gene regulation, hormone action and interaction, the influence of light in development, flowering, fruiting, dormancy, abscission, and senescence.

[BIO S 645 Families of Tropical Flowering Plants
Fall. 1 credit. Prerequisite: written permission of instructor. S-U grades only. Offered alternate years. Not offered 1991–92.
Lec and disc, F 11:15. Bailey Hortorium staff.
The families of flowering plants encountered solely or chiefly in tropical regions are considered in lectures, discussions, and demonstrations, with the aim of providing basic points of recognition for, and an understanding of, diversity and relationships in these families for the student venturing into the tropics.]

[BIO S 646 Families of Tropical Flowering Plants: Field Laboratory
Intersession. 3 credits. Limited to 20 students, with preference given to graduate students from member institutions of the Organization for Tropical Studies. Prerequisite: Biological Sciences 243 or 248 or equivalent. Recommended: Biological Sciences 645. S-U grades only. For more details and application, contact the L. H. Bailey Hortorium, 467 Mann Library. Offered alternate years. Not offered 1991–92.
Bailey Hortorium staff.
An intensive orientation to families of tropical flowering plants represented in forests of the American tropics. Emphasis on field identification combined with laboratory analysis of available materials in a "whole-biology" context.]

BIO S 647 Seminar in Systematic Botany
Fall and spring. 1 credit. May be repeated for credit. Prerequisite: written permission of course coordinator required for undergraduates. S-U grades optional.
Sem, T 11:15–1:10. Bailey Hortorium staff.
Lectures and discussions led by staff, visitors, and students on topics of current importance to systematic botany.

[BIO S 648 Plant Biochemistry
Spring. 3 credits. Prerequisites: organic chemistry, biochemistry, and a course in plant physiology. Offered alternate years. Not offered 1991–92.
Lecs, M W F 9:05. A. T. Jagendorf and staff.
Selected areas of plant biochemistry are reviewed in the context of the plant life cycle and responses to the environment. Topics include metabolism of lipids, carbohydrates, organic acids, and proteins; nitrogen and sulfur assimilation; respiration; photosynthesis; development and replication of chloroplasts; and cell-wall composition and properties. Attention is paid to operation of control mechanisms.]

BIO S 649 Transport of Solutes and Water in Plants
Fall. 3 credits. Prerequisite: Biological Sciences 341 or equivalent. Offered alternate years.
Lecs, M W F 10:10. R. M. Spanswick.
Transport of ions, water, and organic materials in plants; mechanisms of ion transport; relationships between ion transport and metabolism; ion uptake and transport in higher plants; phloem transport; and water relations of single cells and whole plants.

[BIO S 651 Quantitative Whole-Plant Physiology
Fall. 3 credits. Prerequisites: introductory physics, calculus, and plant physiology. S-U grades only. Offered alternate years. Not offered 1991–92.
Lecs, T R 10:10–11:30. R. M. Spanswick.
An exploration of the extent to which physiological processes and their interactions can be formulated in a quantitative manner and integrated to describe various aspects of plant behavior, including growth and yield. Consideration is given to characterization of the plant environment, energy balance, gas exchange, water relations, photosynthesis, respiration, translocation, nutrient supply, and the timing of developmental events.]

BIO S 652 Plant Molecular Biology II
Spring. 1–4 credits (1 credit per section). Prerequisites: Biological Sciences 281, 330 or 331, and 653 (Section 01), or their equivalents. S-U grades optional.
A series of four-week modules on specialized topics. Coordinator: S. H. Howell.

Section 01 Molecular Plant-Pathogen Interactions (also Plant Pathology 662)
1 credit.
Lecs, M W F 10:10 (12 lecs) Jan. 22–Feb. 17. P. F. Palukaitis, O. C. Yoder.
An examination of the molecular properties that control the development of host-parasite interactions in both microorganisms (viruses, bacteria, and fungi) and higher plants. Contemporary theories describing the genetic mechanisms of pathogenesis and resistance are discussed.

Section 02 Molecular Biology of Plant Organelles
1 credit. S-U grades optional.
Lecs, M W F 1:25 (12 lecs) Jan. 22–Feb. 17. M. R. Hanson, D. B. Stern.
An in-depth examination of the molecular biology of plant mitochondria and plastids. Topics include the organization and expression of organelle genomes, cytoplasmic male sterility, gene regulation during plastid development, and organelle transformation.

Section 03 Molecular Aspects of Plant Development II
1 credit. S-U grades optional.
Lecs, M W F 10:10 (12 lecs) Feb. 19–Mar. 23. S. H. Howell.
A systems approach to the study of plant development from a molecular perspective. Topics include *Arabidopsis* as a model plant system; molecular genetics of flowering, seed development, and germination; shoot and root development; senescence; and fruit ripening.

Section 04 Molecular Plant-Microbe Interactions
1 credit. S-U grades optional.
Lecs, M W F 10:10 (12 lecs) Mar. 25–Apr. 20. S. C. Winans, T. A. LaRue.
Course focuses on the interactions of *Agrobacteria* and *Rhizobia* with plants. Topics on *Agrobacterium*-plant interactions include plant-microbe recognition mechanisms, T-DNA transfer process, oncogenesis and use of *Agrobacterium* to produce transgenic plants. Topics on *Rhizobium*-plant interactions include regulation of nitrogenase activity and expression, organization and function of the *sym* plasmid, nodule development, and plant genetics involved in plant-microbe interaction.

BIO S 653 Plant Molecular Biology I
Fall. 1–4 credits (1 credit per section). Prerequisites: Biological Sciences 281 and 330 or 331, or their equivalents. S-U grades optional.
A series of four-week modules on specialized topics. Coordinator: S. H. Howell.

Section 01 Concepts and Techniques in Plant Molecular Biology
1 credit.
Lecs, M W F 10:10 (12 lecs) Sept. 4–Sept. 30. R. L. Last, R. Wu.
A review and update on molecular biology concepts relevant to plant sciences including DNA synthesis, RNA transcription and processing, and protein structure and translation. Methods applicable to plant molecular biology are described including isolation of nucleic acids, gel electrophoresis, recombinant DNA techniques, mutant production, DNA-protein interactions, and use of antibodies.

Section 02 Plant Biotechnology (also Plant Breeding 653 and Plant Pathology 663)
1 credit.
Lecs, M W F 10:10 (12 lecs) Sept. 4–Sept. 30. M. Zaitlin, E. D. Earle.
Applications of molecular biology and tissue culture to plant biotechnology are studied. Topics covered include gene introduction and tissue culture technologies, use of somaclonal variation, use of cultured plant materials and transgenic plants to obtain resistance to insects, plant diseases, and herbicides and to improve nutritional and food processing qualities. Regulatory and social issues relating to plant biotechnology are discussed.

Section 03 Plant Genome Organization and Function (also Plant Breeding 653)
1 credit.
Lecs, M W F 10:10 (12 lecs) Oct. 7–Nov. 4. S. D. Tanksley.
Molecular structure and evolution of plant nuclear genomes are explored. Topics covered include mechanisms for packaging DNA into chromosomes, molecular structure of telomeres and centromeres, DNA replication and methylation, and molecular biology of plant transposons. Methods for genetic and physical mapping of plant genomes are discussed as well as applications of mapping tools for gene isolation and plant breeding.

Section 04 Molecular Aspects of Plant Development I
1 credit.
Lecs, M W F 10:10 (12 lecs) Nov. 6–Dec. 6. J. B. Nasrallah.
The regulation of plant nuclear gene expression during development and in response to environmental stimuli is explored. Topics include the use of classical and molecular genetics, transposable elements, and transgenic plants to identify and characterize *cis*- and trans-acting elements responsible for the regulation of selected genes.

[BIO S 654 Plant Nomenclature
Spring. 1 credit. Prerequisite: written permission of instructor. S-U grades optional. Offered alternate years. Not offered 1991–92.
Lec and disc to be arranged. R. P. Korf.
An analysis of the International Code of Botanical Nomenclature and its application to various plant groups.]

BIO S 656 Topics in Paleobotany
Spring. 1 credit. Prerequisite: Biological Sciences 448 or equivalent background in evolution or written permission of instructor.
Lab and disc to be arranged.
K. J. Niklas.
A series of selected topics to provide a background in plant evolution, paleobotanical literature, and evolutionary theory. Among the topics discussed are the origin of a terrestrial flora, the evolution of the seed plants, and the origin and adaptive radiation of the angiosperms.

[BIO S 657 Literature of Taxonomic Botany
Fall. 1 credit. Prerequisite: written permission of instructor. S-U grades optional. Offered alternate years. Not offered 1991–92.
Lec and disc, R 10:10. Bailey Hortorium staff.
A survey of the basic reference works in taxonomy from the pre-Linnaean literature drawn on by Linnaeus to contemporary publications, with comments on the peculiarities of the books (when appropriate), publication dates, typographic devices, and intricacies of bibliographic citation.]

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

BIO S 742 Current Topics in Plant Molecular Biology
Fall and spring. 1 credit. Limited to 20 students. Primarily for graduate students, with preference given to majors or minors in plant molecular biology; written permission of instructor required for undergraduates. S-U grades only.
Sem, 1 hour each week to be arranged. M. Mutschler.
A seminar with critical presentation and discussion by students of original research papers concerning the molecular biology of plants. Staff direction varies each year and is announced a semester in advance.

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

BIO S 840 Current Topics in Plant Physiology
Fall or spring. 2 credits. May be repeated for credit. S-U grades only.
Sem to be arranged. Staff.
Seminar reports by graduate students on current literature in experimental plant physiology or related areas.

Related Courses in Other Departments

Introductory Mycology (Plant Pathology 309)

Marine Botany: Ecology of Marine Plants (Biological Sciences 449)

Mycology (Plant Pathology 709)

Mycology Conferences (Plant Pathology 649)

Plant Ecology, Lectures and Laboratory (Biological Sciences 463 and 465)

Plant Ecology Seminar (Biological Sciences 669)

Taxonomy of Fungi (Plant Pathology 729)

Teaching Experience (Biological Sciences 498)

Undergraduate Research in Biology (Biological Sciences 499)

ECOLOGY AND EVOLUTIONARY BIOLOGY

BIO S 261 Ecology and the Environment (formerly Principles of Ecology)
Fall or summer. 4 credits. Prerequisite: one year of introductory biology. S-U grades optional.
Lecs, M W F 11:15; disc, W or R 1:25, 2:30, or 3:35. Evening prelim R, Oct. 10. N. G. Hairston, Jr. and staff.
An introduction to principles of ecology concerning the interactions between organisms and their environment. The course deals with both terrestrial and aquatic ecology, drawing examples from both plant and animal studies. Phenomena that occur at the individual population, community, and ecosystem levels of organization are discussed. These principles are extensively applied to current environmental problems and issues.

BIO S 263 Field Ecology
Fall. 2 credits. Prerequisite: concurrent or previous enrollment in Biological Sciences 261. Limited to 16 students.
Lec, R 1:25; lab, F 12:20–5. One weekend field trip to the Hudson Valley. P. L. Marks.
Field exercises designed to give students direct experience with field work, with emphasis on developing observational skills, journal keeping, and a landscape perspective. Topics include plant succession, niche relationships of insects, influence of herbivores and competition on plant performance, decomposition of soil litter, sampling plankton, and use of scientific collections.

BIO S 272 Functional Ecology: How Animals Work
Spring. 4 credits. Prerequisite: one year of introductory biology for majors. Offered alternate years. Fee, $15.
Lecs, M W F 9:05; lab, T or R 1:25–4:25. F. H. Pough.
An introductory course for students interested in organismal biology. The features of the physical environment that are important to insects and vertebrates are used to illustrate the interaction of physiological, behavioral, and morphological characteristics in organismal activity and homeostasis. Laboratories include a survey of the diversity of endothermal and ectothermal animals, ecophysiological measurements, and measurements of important environmental parameters in local habitats. This course uses live and preserved vertebrate animals for field observations and laboratory exercises.

[BIO S 274 Functional and Comparative Morphology of Vertebrates
Spring. 4 credits. Prerequisite: one year of introductory biology. Offered alternate years. Not offered 1991–92. Fee, $15.
Lecs, M W 12:20; labs, M W or T R 1:25–4:25. D. K. McClearn.
An exploration of the relations between form and function in biological systems with an emphasis on trends in vertebrate evolution. Lectures integrate data from topics such as locomotion, feeding, size and scaling with issues of historical importance and current interest (e.g., correlation of body parts, adaptationist explanations, developmental constraints, criteria for determining biomechanical and energetic "efficiency"). Laboratories include dissections of preserved vertebrate animals and noninvasive live animal demonstrations (motion analysis, surface electrode, and force-plate recordings).]

BIO S 275 Human Biology and Evolution (also Anthropology 275 and Nutritional Sciences 275)
Fall. 3 or 4 credits (4 credits with discussion). S-U grades optional, with permission of either instructor.
Lecs, M W F 10:10; optional disc to be arranged. K. A. R. Kennedy, J. D. Haas.
An introduction to the biology of *Homo sapiens* through an examination of human evolution, biological diversity, and modes of adaptation to past and present environments. Evolutionary theory is reviewed in relation to the current evidence from the fossil record and studies of the evolution of human behavior. A survey of human adaptation covers a complex of biological and behavioral responses to environmental stress. Human diversity is examined as the product of long-term evolutionary forces and short-term adaptive responses. Topics such as creationism, the Piltdown fraud, the sociobiology debate, genetic engineering, race and IQ, and racism are presented as examples of current issues in human biology. These topics and others are the focus of the optional one-hour weekly discussions.

BIO S 371 Human Paleontology (also Anthropology 371)
Fall. 4 credits. Prerequisite: one year of introductory biology or Anthropology 101 or permission of instructor. Offered alternate years.
Lecs, M W F 2:30; lab, 1 hour each week to be arranged; occasional field trips. K. A. R. Kennedy.
A broad survey of the fossil evidence for human evolution with special attention to skeletal and dental anatomy, geological contexts, paleoecology, dating methods, archaeological associations, and current theories of human origins and physical diversity.

[BIO S 373 The Invertebrates: Form, Function, and Evolution
Fall. 4 credits. Limited to 30 students. Prerequisite: one year of introductory biology for majors. Offered alternate years. Not offered 1991–92.
Lecs, M W F 10:10; lab, W 1:25–4:25; one optional weekend field trip to Shoals Marine Laboratory. Small fee for the field trip. C. D. Harvell.
An introduction to the evolution of form and function among the major invertebrate phyla. Strong emphasis is placed on the integration of evolutionary pasts and ecological presents to produce extant forms. Lectures draw heavily on original literature from the field of invertebrate functional morphology. Laboratory dissections and demonstrations often involve live marine and freshwater invertebrates.]

BIO S 378 Evolutionary Biology
Spring. 4 credits. Enrollment may be limited. Prerequisite: one year of introductory biology or permission of instructor. S-U grades optional.
Lecs, M W F 10:10; disc, 1 hour each week to be arranged. Evening prelims Feb. 25 and Apr. 2. R. G. Harrison, M. A. Geber.
The course considers explanations for patterns of diversity and for the apparent "good fit" of organisms to the environment. Topics covered include the genetic and developmental basis of evolutionary change, processes at the population level, the theory of evolution by natural selection, levels of selection, concepts of fitness and adaptation, modes of speciation, long-term trends in evolution, rates of evolution, and extinction.

BIO S 455 Insect Ecology (also Entomology 455)
Fall. 3 credits. Prerequisites: Biological Sciences 261 and Entomology 212 or their equivalents. Offered alternate years.
Lecs, W F 11:15; disc, 1 hour each week to be arranged. R. B. Root.
Ecological and evolutionary principles are integrated by thorough examination of outstanding investigations. Topics include the factors responsible for the great diversity of insects, adaptive syndromes associated with climate, natural history of arthropod guilds, impact of insects on terrestrial vegetation, population regulation, and the contrast between natural and managed ecosystems.

[BIO S 456 Stream Ecology (also Entomology 456)
Spring. 3 credits. Prerequisite: Recommended Biological Sciences 261. S-U grades optional, with permission of instructor. Offered alternate years. Not offered 1991–92.
Lecs, T R 11:15; labs, T or R 1:25–4:25. B. L. Peckarsky, C. M. Pringle.
Lecture addresses the question, How does flow influence the structure and function of stream ecosystems? Aspects of structure include channel morphometry; physical and chemical gradients; and plant, invertebrate, and fish community structure. Functional analyses include nutrient cycling and downstream transport, trophic dynamics, processes affecting plant and animal colonization and succession, and the impacts of anthropogenic disturbances. Laboratory includes three or four class projects using descriptive, behavioral, and experimental techniques in the laboratory and the field to test hypotheses discussed in lecture.]

[BIO S 457 Limnology, Lectures
Fall. 3 credits. Prerequisite: Biological Sciences 261 or written permission of instructor. Recommended: introductory chemistry. Not offered 1991–92.
Lecs M W F 11:15. N. G. Hairston, Jr.
The study of continental waters, with emphasis on lakes and ponds. Factors regulating nutrients, population and community dynamics of freshwater organisms, and physical and chemical properties of fresh water are considered.]

[BIO S 459 Limnology, Laboratory
Fall. 2 credits. Prerequisite: concurrent or previous enrollment in Biological Sciences 457. Not offered 1991–92.
Lab, T W or R 1:25–4:25; 1 weekend field trip. N. G. Hairston, Jr. and staff.
Laboratories and field trips devoted to studies of the biological, chemical, and physical properties of lakes and other freshwater environments. Vertebrate dissection (fish) during one laboratory exercise and during a portion of weekend field trip.]

BIO S 460 Physiological Plant Ecology
Spring. 4 credits. Prerequisite: Biological Sciences 261 or introductory plant physiology. S-U grades optional, with permission of instructor. Offered alternate years. Fee, $15.
Lecs, T R 11:15; disc, R 1:25; lab, T 1:25–4:25. T. E. Dawson.
A detailed survey of the physiological approaches used in understanding 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. Laboratories apply physiological techniques to specific ecological problems and cover aspects of experimental design and computer-aided data analysis. Some laboratories may run past the three-hour period.

BIO S 461 Population and Evolutionary Ecology
Fall. 4 credits. Prerequisite: Biological Sciences 261 or 378. S-U grades optional. Offered alternate years.
Lecs, M W F 9:05; lab, M 1:25–4:25. D. W. Winkler and S. A. Levin.
Problems of ecology are viewed from an evolutionary perspective, exploring issues of adaptation and fitness definition by developing advanced understanding of demography and interspecific interactions. Blending theory and empirical findings, the course explores population dynamics; life-history theory; dispersal; competition; predation; parasite-host coevolution; mutualisms; and sexual, kin, and group selection. Methods of estimation and analysis are learned in laboratory.

BIO S 462 Marine Ecology
Spring. 3 credits. Prerequisite: Biological Sciences 261. Offered alternate years.
Lecs and disc, M W F 10:10. Staff.
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.

[BIO S 463 Plant Ecology and Population Biology, Lectures (formerly Plant Ecology, Lectures)
Fall. 3 credits. Prerequisites: introductory course in ecology or evolution (e.g., Biological Sciences 261 or 378), or permission of instructor. Recommended: some taxonomic familiarity with vascular plants and concurrent enrollment in Biological Sciences 465. Offered alternate years. Not offered 1991–92.
Lecs, M W F 11:15. M. A. Geber, P. L. Marks.
This course examines the biological and historical factors affecting the structure of plant communities, and the distribution, abundance, and population dynamics of individual species. The influence of the environment, disturbance history, competition, and herbivory on the organization of plant communities are considered first. Plant populations are then studied through an analysis of plant life histories and plant-plant and plant-animal interactions. Throughout the course an attempt is made to blend empirical patterns, experimental results, and theory. Readings are drawn from the primary literature.]

BIO S 464 Microevolution and Macroevolution (also Entomology 464)
Spring. 4 credits. Limited to 25 students. Prerequisite: Biological Sciences 378 or permission of instructor. S-U grades optional, with permission of instructor. Offered alternate years.
Lecs, T R 10:10–11:30; disc, one hour each week to be arranged. A. R. McCune and S. Via.
An advanced course in evolutionary biology integrating macroevolutionary and microevolutionary approaches. Areas of emphasis include patterns and processes of speciation, phylogeny reconstruction in populations and higher taxa, the origins and fate of variation, and causes of major evolutionary transitions. Discussion of these problems involve data and approaches from genetics, morphology, systematics, paleobiology, development, and ecology.

[BIO S 465 Plant Ecology and Population Biology, Laboratory (formerly Plant Ecology, Laboratory)
Fall. 1 credit. Prerequisite: concurrent enrollment in Biological Sciences 463. Offered alternate years. Not offered 1991–92.
Lab, F 12:05–5. M. A. Geber, P. L. Marks.
Laboratory and field exercises designed to give firsthand experience with the ecology and population biology of plants. Emphasis is on making observations and measurements of plants in the field and greenhouse, and on simple data analysis.]

BIO S 467 Physiological Animal Ecology
Fall. 4 credits. Prerequisite: Biological Sciences 272 or 274. Offered alternate years.
Lecs, T R 11:15; disc, R 1:25; lab, T 1:25–4:25. A. C. Huntley.
The course examines how living organisms function in their environment. Classical physiological topics including respiration, circulation, excretion, osmoregulation, metabolism, and integration are addressed in evolutionary and ecological contexts. The theme is organismal adaptation and response to major environmental factors such as temperature, food availability, oxygen, and water. Laboratory exercises demonstrate physiological principles discussed in lectures, cover current experimental physiological methods and techniques, and emphasize experimental design. Some laboratories may run beyond the stated time limit. During the second half of the semester students design and execute an independent research project. Results of this project are presented during the final laboratory section. Live vertebrate animals are used for field observations and laboratory exercises.

[BIO S 470 Ecological Genetics (also Entomology 470)
Spring. 4 credits. Prerequisite: Biological Sciences 378 or permission of instructor. S-U grades optional. Offered alternate years. Not offered 1991–92.
Lecs, T R 10:10–11:30; disc, one hour each week to be arranged. S. Via.
A study of the relationships between genetic and ecological processes in populations. Topics include consequences of genetic variation in age-structured populations; demographic concepts of fitness; evaluation of methods for measuring genetic variation and natural selection on ecologically important traits; genetics of competitive ability and predator avoidance; genetic and ecological aspects of phenotypic plasticity; character displacement; maintenance of genetic variability; limits to selection. How theory can be used to formulate hypotheses about evolutionary mechanisms in natural populations is considered and experiments designed to test such hypotheses are evaluated.]

BIO S 471 Mammalogy
Fall. 4 credits. Recommended: Biological Sciences 274. S-U grades optional, with permission of instructor. Offered alternate years. Fee, $15.
Lecs, M W F 9:05; lab, M or T 1:25–4:25; 1 weekend field trip required.
D. K. McClearn.
Lectures on the evolution, classification, distribution, and adaptations of mammals. Laboratory and fieldwork on systematics, ecology, and natural history of mammals of the world, with primary emphasis on the North American fauna. Systematics laboratories held in the museum at Research Park. Live animals are studied in the field and are sometimes used in the laboratory for nondestructive demonstrations or experiments. The systematics laboratory exercises are based on museum specimens.

[BIO S 472 Herpetology
Spring. 4 credits. Recommended: Biological Sciences 274. S-U grades optional, with permission of instructor. Offered alternate years. Fee, $10. Not offered 1991–92.
Lecs and labs, T R 12:20–4:25; occasional field trips and special projects.
F. H. Pough.
Lectures cover various aspects of the biology of amphibians and reptiles, including evolution, zoogeography, ecology, behavior, and physiology. Laboratory includes systematics, functional morphology, and behavior. Live animals are studied in the field and are sometimes used in the laboratory for nondestructive demonstrations or experiments. The systematics laboratory exercises are based on museum specimens.]

[BIO S 473 Ecology of Agricultural Systems (also Soil, Crop, and Atmospheric Sciences 473)
Fall. 3 credits. Limited to 45 students. Prerequisite: Biological Sciences 261 or permission of instructor. S-U grades optional. Offered alternate years. Not offered 1991–92.
Lec and disc, T R 2:30–3:45. During the first 6 weeks of class the Thursday meetings may run to 5:00 because of field trips. A. G. Power, T. W. Scott.
Analysis of the ecological processes operating in agricultural systems, with an emphasis on the interactions between organisms. Topics include nutrient dynamics in agroecosystems, plant competition and facilitation, intercropping, the ecology of species invasions, mutualism in agroecosystems, plant-herbivore relations, plant-pathogen interactions, biological pest control, and evolutionary processes in agriculture. Case studies from both the tropics and the temperate zone are used to illustrate important concepts.]

[BIO S 474 Laboratory and Field Methods in Human Biology (also Anthropology 474)
Spring. 5 credits. Prerequisite: one year of introductory biology or Anthropology 101 or permission of instructor. Offered alternate years. Not offered 1991–92.
Lecs and labs, T R 10:10–12:05; additional hours to be arranged. Independent research project required.
K. A. R. Kennedy.
Practical exercises and demonstrations of modern approaches to the methodology of physical anthropology. Emphasis on comparative human anatomy, osteology, description of skeletal and living subjects, paleopathology, skeletal maturation, and relevant field techniques for the archaeologist and forensic anthropologist. This course includes dissection of a profused nonhuman primate.]

[BIO S 475 Ornithology
Fall. 4 credits. Recommended: Biological Sciences 274. S-U grades optional, with permission of instructor. Limited to 30 students. Offered alternate years. Fee, $15. Not offered 1991–92.
Lecs and labs, T R 12:20–4:25; occasional field trips and special projects.
D. W. Winkler.
Lectures cover various aspects of the biology of birds, including anatomy, physiology, systematics, evolution, behavior, ecology, and biogeography. Laboratory includes dissection of dead material, studies of skeletons and plumages, and specimen identification of avian families of the world and species of New York. Independent projects emphasize research skills.]

[BIO S 476 Biology of Fishes
Fall. 4 credits. Recommended: Biological Sciences 272 or 274 or equivalent experience in vertebrate zoology. S-U grades optional, with permission of instructor. Offered alternate years. Not offered 1991–92.
Lecs, M W F 9: 05; lab, M 1:25–4:25.
A. R. McCune.
An introduction to the study of fishes: their structure, evolution, distribution ecology, physiology, behavior, classification, and identification, with emphasis on local species. 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.]

[BIO S 478 Ecosystem Biology
Spring. 4 credits. Prerequisite: Biological Sciences 261 or equivalent. S-U grades optional. Offered alternate years. Not offered 1991–92.
Lecs and disc, T R 10:10–12:05.
R. W. Howarth.
Analysis of ecosystems in terms of energy flow and nutrient cycles, emphasizing an experimental approach and comparative aspects of terrestrial, freshwater, and marine ecosystems. Consideration of anthropogenic effects on ecosystems, such as from acid precipitation and offshore oil pollution. Discussion of the interactions between ecosystem processes and community structure.]

BIO S 479 Paleobiology (also Geological Sciences 479)
Fall. 3 credits. Prerequisites: one year of introductory biology for majors and either Biological Sciences 272 or 274, Geological Sciences 375, Biological Sciences 373, or permission of instructor. Offered alternate years.
Lecs, M W F 12:20. J. L. Cisne and staff.
A survey of the major groups of organisms and their evolutionary histories. Intended to fill out the biological backgrounds of geology students and the geological backgrounds of biology students concerning the nature and significance of the fossil record for their respective studies.

BIO S 660 Field Studies in Ecology and Systematics
Spring. Variable credit. Prerequisites: Biological Sciences 261, a taxon-oriented course, and permission of instructor. Estimated cost of room and board (exclusive of transportation) to be announced.
Lecs and labs to be arranged. Staff.
This course provides students an opportunity to learn techniques and a new biota by participating in an intensive series of field exercises. An extended field trip is scheduled during either intersession or spring break. The region visited, trip objectives, and other details are announced by the instructor in charge in the division's catalog supplement issued at the beginning of the semester. Meetings on campus are devoted to orientation and reports on completed projects.

BIO S 661 Environmental Policy (also ALS 661 and Biology and Society 461)
Fall and spring. 3 credits each term. (Students must register for 6 credits each term, since an "R" grade is given at the end of the fall term.) Limited to 12 students. Prerequisite: permission of instructor.
Sem, R 2:30–4:30. D. Pimentel.
This course uses an interdisciplinary approach to focus on complex environmental and energy problems. Ten to twelve students, representing several disciplines, investigate significant environmental problems. The research team spends two semesters preparing a scientific report for publication in *Science* or *BioScience*.

[BIO S 662 Mathematical Ecology (also Statistics and Biometry 662)
Spring. 3 credits. Prerequisites: one year of calculus and a course in statistics. Recommended: a general ecology course. S-U grades optional, with permission of instructor. Offered alternate years. Not offered 1991–92.
Lecs, M W F 12:20. S. A. Levin, C. Castillo-Chavez.
Mathematical and statistical analysis of populations and communities: theory and methods. Spatial and temporal pattern analysis. Deterministic and stochastic models of population dynamics. Model formulation, parameter estimation, simulation, and analytical techniques.]

[BIO S 664 Seminar in Insect-Plant Interactions (also Entomology 664)
Spring. 2 credits. Intended for seniors and graduate students. Limited to 15 students. Prerequisites: courses in entomology, ecology, evolution, and organic chemistry and written permission of instructor. S-U grades optional. Offered alternate years. Not offered 1991–92.
Sem, 1 evening each week to be arranged. P. P. Feeny.
Presentations and discussions by students on the evolution of patterns of interaction between plants and insects, emphasizing critical evaluation of concepts and evidence.]

[BIO S 665 Limnology Seminar
Spring. 1 credit. May be repeated for credit. Primarily for graduate students; written permission of instructor required for undergraduates. S-U grades optional. Offered alternate years. Not offered 1991–92.
Sem to be arranged. N. G. Hairston, Jr.
A seminar course on advanced topics in freshwater ecology.]

[BIO S 668 Comparative Biogeochemistry
Fall. 4 credits. Prerequisites: solid background in ecology, environmental chemistry, or related environmental science. Permission of instructor required for undergraduates. S-U grades optional. Offered alternate years. Not offered 1991–92. Next offered fall 1992, spring 1994, and alternate spring semesters thereafter.
Lecs and disc, T R 10:10–12:05.
R. W. Howarth.
Lectures cover the biotic controls on the chemistry of the environment. Emphasis is on cycles of major elements and minor elements globally and in selected ecosystems, stressing the coupling of element cycles. A comparative approach is used to illustrate similarities and differences in element cycling among ecosystems, with slight emphasis on aquatic ecosystems. Analysis of both theoretical and applied issues, including global atmospheric changes and factors controlling the acidification of lakes.]

BIO S 669 Plant Ecology Seminar
Spring. 1 credit. May be repeated for credit. Suggested for students majoring or minoring in plant ecology. S-U grades optional.
Sem to be arranged. Staff.
Includes review of current literature, student research, and selected topics of interest to participants.

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

BIO S 672 Graduate Seminar in Physiological Ecology
Spring. 2 credits. Prerequisite: a course in plant or animal physiology, especially Biological Sciences 460 or 467. May be repeated for credit. Permission required for undergraduates. S-U grades only. Offered alternate years.
Sem, one 2-hour meeting per week.
F. H. Pough, T. E. Dawson,
A. C. Huntley, B. F. Chabot.
Discussion of topics on water balance, energetics, and temperature regulation emphasize parallels and contrasts in the relations of animals and plants to their biophysical environments. Each student leads a discussion and prepares a written review of a topic, drawing on the primary literature of his or her own research interests.

[BIO S 673 Human Evolution: Concepts, History, and Theory (also Anthropology 673)
Fall. 3 credits. Prerequisite: one year of introductory biology, Anthropology 101, or permission of instructor. Offered alternate years. Not offered 1991–92.
Sem, W 7:30–9:30 p.m.; additional hours to be arranged. K. A. R. Kennedy.
The historical background of present-day concepts of man's evolutionary variations and adaptations in space and time is surveyed. The formation of biological anthropology as an area of scientific inquiry within the social and biological sciences is reviewed. Students select their own topics within a broad range of readings in the history of Western concepts of human origins, diversity, and place in nature.]

BIO S 674 Principles of Systematics (also Entomology 674)
Spring. 4 credits. Limited to 15 students. Prerequisite: permission of instructor. Recommended: an introductory biological systematics course. Offered alternate years.
Lecs, discs, and labs, M W 1:25–4:25.
Q. D. Wheeler and staff.
An introduction to modern theory and methods of systematic biology. Lectures are on theoretical systematics and include species concepts, classification, phylogenetics, and biogeography. Laboratories include modern methods of analysis of data, including cladistic hand and computer methods and numerical methods. Laboratory grade is based in part on a final paper.

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

[BIO S 765 Autecology/Population Ecology
Fall. 4 credits. Prerequisite: Biological Sciences 261 or equivalent. S-U grades optional. Not offered 1991–92.
Lecs and discs, T R 10:10–12:05. Staff.
Comparison of the responses and adaptations of organisms to environments in selected ecosystems. Emphasis on similarities and differences in molecular and organismal mechanisms by which plants and animals cope with their environments. Critical examination of the properties and dynamics of populations. Emphasis on theories of adaptation, population structures, dynamics, and regulation.]

[BIO S 766 Communities and Ecosystems
Spring. 4 credits. Prerequisite: Biological Sciences 261 or equivalent. S-U grades optional. Not offered 1991–92.
Lecs, T R 10:10–12:05. Staff.
Structure, dynamics, and evolution of natural communities; species diversity; niches and gradient relations; and succession, climax, and disturbance. Comparative aspects of terrestrial, marine, and freshwater communities. Analysis of ecosystems in terms of energy flow, biogeochemistry, and model systems. Emphasis on functional and structural properties of communities and ecosystems.]

BIO S 767 Current Topics in Ecology and Evolutionary Biology
Fall. 4 credits. Prerequisites: Biological Sciences 261 and 378 or their equivalents. S-U grades optional.
Lecs and discs, T R 10:10–12:05. Staff.
Critical evaluation and discussion of theory and research in ecology and evolutionary biology. Lectures by faculty and student-led discussions of topics in areas of current importance.

Related Courses in Other Departments

Advanced Soil Microbiology (Soil, Crop, and Atmospheric Sciences 666)

Advanced Work in Parasitology (Veterinary Medicine 737)

Animal Social Behavior (Biological Sciences 427)

Biology of Plant Species (Biological Sciences 442)

Early People: The Archaeological and Fossil Record (Anthropology 203 and Archaeology 203)

Marine Sciences Courses (Biological Sciences 363–370, 467, 477)

Plant Geography (Biological Sciences 440)

Related Courses in Entomology (Entomology 212, 331, 332, 370, 453, 471, 621, 631, 633, 634, 636, 672)

Related Courses in Natural Resources (Natural Resources 270, 302, 603)

Taxonomy of Vascular Plants (Biological Sciences 248)

Teaching Experience (Biological Sciences 498)

Undergraduate Research in Biology (Biological Sciences 499)

Undergraduate Seminar in Biology (Biological Sciences 400)

Veterinary Parasitology (Veterinary Medicine 510)

GENETICS AND DEVELOPMENT

BIO S 281 Genetics
Fall, spring, or summer (8-week session). 5 credits. Not open to freshmen in fall semester. Enrollment may be limited to 200 students. Prerequisite: one year of introductory biology or equivalent. Students who have taken Biological Sciences 282 may register only with written permission of instructor. No admittance after first week of classes.

Lecs, T R 10:10–12:05; lab, T W or F 2:30–4:25; additional hours to be arranged. Students do not choose lab sections during course enrollment; lab assignments are made during first day of classes. T. D. Fox, M. L. Goldberg, R. J. MacIntyre.

A general study of the fundamental principles of genetics in eukaryotes and prokaryotes. Discussions of gene transmission, gene action and interaction, gene linkage and recombination, gene structure, gene and chromosome mutations, genetic aspects of differentiation, genes in populations, breeding systems, and extrachromosomal inheritance. Aspects of recombinant DNA technology are discussed. In the laboratory, students perform experiments with microorganisms and conduct an independent study of inheritance in *Drosophila*.

BIO S 282 Human Genetics
Spring. 2 or 3 credits (2 credits if taken after Biological Sciences 281). Each discussion limited to 25 students. Prerequisite: one year of introductory biology or equivalent; written permission of instructor required for students who have taken Biological Sciences 281. S-U grades optional.

Lecs, M W 10:10 (lecs, also F 10:10 1st 3 weeks only); disc, R 10:10 or F 10:10 or 11:15. R. A. Calvo.

A course designed for nonmajors. Lectures provide the technical background needed to understand controversial personal, social, and legal implications of modern genetics that are discussed in section meetings.

BIO S 385 Developmental Biology
Fall. 3 credits. Prerequisite: Biological Sciences 281.

Lecs, M W F 11:15. A. W. Blackler.

An introduction to the morphogenetic, cellular, and genetic aspects of the developmental biology of animals.

BIO S 389 Embryology
Spring. 3 credits. Prerequisites: one year of introductory biology and a knowledge of mammalian adult anatomy. Limited to seniors.

Lecs, T R 10:10; labs, T R 2–4:25. A. W. Blackler.

A course in the embryonic development of vertebrate animals, with emphasis on the comparative aspects of morphogenesis and function at the tissue level. The laboratory has a strong morphogenetic bias, emphasizing the comparative aspects of developmental anatomy. Preserved materials are used in the laboratory.

BIO S 480 Seminar in Developmental Biology
Spring. 1 credit. May be repeated for credit. Limited to upperclass students. S-U grades only.

Sem to be arranged. Staff.

[BIO S 481 Population Genetics
Fall. 4 credits. Prerequisite: Biological Sciences 281 or equivalent. Not offered 1991–92.

Lecs, M W F 10:10; disc, M 2:30 or T 1:25. C. F. Aquadro.

A study of factors that influence the genetic structure of Mendelian populations and that are involved in race formation and speciation. 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. The interplay between theory and the data from experiments and natural populations are emphasized.]

BIO S 482 Human Genetics and Society
Fall. 3 credits. Prerequisites: Biological Sciences 281 and 330 or 331. Enrollment limited to senior biological sciences majors, with preference given to students studying genetics and development. S-U grades optional.

Disc, T 2:30–4:25 and R 2:30–3:30 or 3:30–4:30. R. A. Calvo, H. T. Stinson.

Presentation of the technology and discussion of the ethical, social, and legal implications of recent advances in human genetics. Among the topics that may be considered are new reproductive strategies, eugenics, genetic counseling, genetic screening (prenatal, neonatal, presymptomatic, carrier, and workplace), wrongful life and wrongful birth, genetic effects of abused substances, genetics and behavior, and therapy for genetic diseases. Students lead most discussions. There is a major writing component in the course.

[BIO S 483 Molecular Aspects of Development
Spring. 3 credits. Prerequisites: Biological Sciences 281, 330 or 331, and 385. Offered alternate years. Not offered 1991–92.

Lecs, T R 10:10–11:25. W. H. Mark.

An examination of the molecular biology of developing systems, with emphasis on the genomic, transcriptional, post-transcriptional, translational, and post-translational mechanisms involved in regulating development. Both prokaryotic and eukaryotic systems are considered, but emphasis is on the latter. Topics to be discussed include changes in chromatin structure, DNA rearrangements, control of RNA synthesis and processing, translational controls, nucleo-cytoplasmic interactions, and genetic responses to hormone treatment. The regulation of selected developmental systems is considered in detail.]

BIO S 484 Molecular Evolution
Spring. 3 credits. Prerequisites: Biological Sciences 281 and organic chemistry. Offered alternate years.

Lecs, T R 11:15. R. J. MacIntyre.

An analysis of evolutionary changes in proteins and nucleic acids, and gene-enzyme variability in natural populations. Theories on the evolution of the genetic code and the construction of phylogenetic trees from biochemical data are discussed. The second half of the course concerns the evolution and the organization of genomes from viruses to higher eukaryotes.

BIO S 485 Microbial Genetics, Lectures
Fall. 2 credits. Limited to upperclass and graduate students. Prerequisites: Biological Sciences 281 and Microbiology 290, or written permission of instructor. S-U grades optional.

Lec, W 7:30–9:25 p.m. S. A. Zahler.

Genetics of bacteria and their viruses, with emphasis on the mechanisms of genetic phenomena. The first half of the course deals with the biosynthesis of proteins, RNA, and DNA by bacteria; how bacteria control those syntheses; the mechanisms of DNA repair and recombination; and types of mutations that occur. The second half of the course deals with more specific questions: transformation in various bacteria; plasmids and their roles in mating, genetic engineering, antibiotic resistance, and pathogenicity; and the molecular biology of selected bacteriophages (mainly T4, T7, M13, ΦX174, MS2, lambda, and Mu).

BIO S 487 Microbial Genetics, Laboratory
Fall. 3 credits. Primarily for upperclass students. Limited to 16 students. Prerequisites: concurrent or previous enrollment in Biological Sciences 485, Microbiology 291 or equivalent, and written permission of instructor.

Lab, T 1:25–4:25; additional hours to be arranged. S. A. Zahler.

Problem solving in bacterial genetics.

[BIO S 684 Advanced Topics in Population Genetics
Spring. 2 credits. Limited to 20 students. Prerequisites: Biological Sciences 481 or equivalent and written permission of instructor. S-U grades optional. Offered alternate years. Not offered 1991–92.

Lec, T 2:30–4:25. C. F. Aquadro.

An in-depth exploration of current areas of research in population genetics. Readings primarily from recent books and the current literature. Specific topics announced the previous fall and in the division's catalog supplement. Format includes lectures, discussion, and presentations by students.]

BIO S 686 Mammalian Development
Spring. 3 credits. Limited to 25 students. Prerequisites: Biological Sciences 281, 330 or 331, and 385 or their equivalents. S-U grades optional. Offered alternate years.

Lecs, T R 10:10–11:25. W. H. Mark.

An in-depth study of mammalian development using the mouse as the animal model. The course covers classical embryology beginning with gametogenesis followed by morphogenetic and biochemical analyses of pre- and post-implantation development. Current topics in experimental embryology, including genetic analysis of mutants, study of cell lineage with chimeras, *in vitro* culturing of embryonic stem cells, and molecular approaches to understanding development are examined.

BIO S 687 Developmental Genetics
Fall. 2 credits. Limited to 20 students. Prerequisites: Biological Sciences 281 or equivalent, Biological Sciences 385 or equivalent. S-U grades optional. Offered alternate years.
Lec, to be arranged. K. J. Kemphues.
Selected topics focus on the use of genetic analysis in understanding mechanisms of development. Topics are drawn primarily from studies in *Drosophila*, *Caenorhabditis*, and Mouse. Other possible topics include pattern formation, cell lineage, neural development, maternal information in development, germ cell development, sex determination, and intercellular communication. Students read current literature and are given the opportunity to discuss each topic in class.

[BIO S 688 Yeast Genetics
Spring. 2 credits. Prerequisites: Biological Sciences 281, 330 or 331, and 485, or written permission of instructor. S-U grades optional. Offered alternate years. Not offered 1991–92.
Lecs, W 7:30–9:25 p.m. T. D. Fox.
An advanced overview of genetic studies in yeast, primarily *Saccharomyces cerevisiae*. Both formal genetic and molecular approaches to selected problems of biological interest are discussed.]

BIO S 780 Current Topics in Genetics
Fall and spring. 2 credits. May be repeated for credit. Primarily for graduate students, with preference given to majors in the Field of Genetics; written permission of instructor required for undergraduates. Limited to 20 students. No auditors. S-U grades optional, with permission of instructor.
Sem to be arranged. Staff.
A seminar course with critical presentation and discussion by students of original research papers in a particular area of current interest. Content of the course and staff direction vary each year and are announced a semester in advance.

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

BIO S 782–787 Current Genetics/ Development Topics
Fall or spring. 1/2 or 1 credit for each topic. May be repeated for credit. S-U grades only.
Lectures and seminars on specialized topics to be announced.

Related Courses in Other Departments

Animal Cytogenetics (Animal Science 419)

Animal Development (Veterinary Medicine 507)

Current Topics in Biochemistry (Biological Sciences 731–736)

Evolutionary Biology (Biological Sciences 378)

Immunogenetics (Animal Science 486)

Laboratory in Plant Molecular Biology (Biological Sciences 641)

Plant Growth and Development (Biological Sciences 644)

Plant Molecular Biology I (Biological Sciences 653)

Reproduction and Development of Marine Invertebrates (Biological Sciences 488)

Undergraduate Research in Biology (Biological Sciences 499)

MICROBIOLOGY

BIO S 290 General Microbiology, Lectures
Fall, spring, or summer (6-week session). 3 credits. Prerequisites: Biological Sciences 101–102 and 103–104 and Chemistry 104 or 208, or equivalent. Recommended: concurrent registration in Biological Sciences 291.
Lecs, M W F 11:15. M. L. Cordts.
A comprehensive overview of the biology of microorganisms, with emphasis on bacteria. The biology of eukaryotic microorganisms and viruses is also discussed. Topics include microbial cell structure and function, physiology and metabolism, genetics, diversity, and ecology. Applied aspects of microbiology are also covered such as biotechnology, immunology, and the role of microorganisms in environmental processes and disease.

BIO S 291 General Microbiology, Laboratory
Fall or spring, 2 credits. Summer (6-week session), 2 or 3 credits. Prerequisite: Biological Sciences 290 (may be taken concurrently).
Labs, M W 2–4:25, or T R 8–10:30, 11:15–1:45, or 2–4:25. C. M. Rehkugler.
A study of the basic principles and techniques of laboratory practice in microbiology, and fundamentals necessary for further work in the subject.

BIO S 292 General Microbiology, Discussion
Spring. 1 credit. Prerequisite: Biological Sciences 290 (may be taken concurrently). S-U grades only.
Disc, hours to be arranged.
C. M. Rehkugler and E. Seacord.
A series of discussion groups in specialized areas of microbiology to complement Biological Sciences 290.

BIO S 300 Seminar in Microbiology
Spring. 1 credit. Limited to undergraduate students in the microbiology program of study. Required for microbiology students in their sophomore year. S-U grades only.
Sem, W 12:20. Staff.
A series of lectures and seminars designed to present students with laboratory safety training and acquaint them with research projects in microbiology on the Cornell campus.

[BIO S 304 Pathogenic Bacteriology and Mycology (also Veterinary Medicine 318)
Spring. 2 or 4 credits (4 credits with lecture and laboratory). Limited to 40 students. Prerequisites: Biological Sciences 290 and 291; strongly recommended: Biological Sciences 305 and 307. Offered alternate years. Not offered 1991–92.
Lecs, T R 1:25; labs, T R 2:25–5.
T. H. Kawula, L. E. Winter.
The study of the major bacterial and fungal agents of infectious disease, with emphasis on the function of virulence mechanisms and the host-parasite interaction. Lectures cover the significance of normal flora, antibiotic therapy and drug resistance, and vaccine development. Laboratories emphasize techniques for isolation, culture, and identification of infectious agents. Animal models are used to help understand certain pathogenic mechanisms.]

BIO S 305 Basic Immunology, Lectures (also Veterinary Medicine 315)
Fall. 3 credits. Strongly recommended: basic courses in microbiology, biochemistry, and genetics.
Lecs, T R 8:30–9:55. Evening prelims: Sept. 26, Oct. 17, and Nov. 14.
A. J. Winter.
A survey of immunology, with emphasis on the biological functions of the immune response.

BIO S 307 Basic Immunology, Laboratory (also Veterinary Medicine 316)
Fall. 2 credits. Prerequisite: a course in basic microbiology or permission of instructor. Recommended: concurrent enrollment in Biological Sciences 305.
Labs, T R 10:10–1:10. N. L. Norcross.
A series of laboratory exercises selected to illustrate immunological concepts presented in Biological Sciences 305. Exercises are designed to give students experience with the stimulation and measurement of an immune response in the rabbit. Techniques to familiarize students with both humoral and cellular immune phenomena are included, with the goal of offering hands-on experience in immunology. Among the methods and techniques offered are agglutination and precipitation methods, virus neutralization and phagocytosis, measurement of the biological activity of complement components, antibody-dependent cell-mediated cytotoxicity, T and B cell identification, monoclonal antibodies and the ELISA, antibody production by single cells, lymphocyte blastogenesis, and delayed hypersensitivity.

BIO S 308 Pathogenic Virology (also Veterinary Medicine 317)
Spring. 4 credits. Limited to 40 students. Prerequisites: Microbiology 290, 291. Recommended: Biological Sciences 305. Offered alternate years.
Lecs, T R 1:25; labs, T R 2:25–4:25. Evening prelims to be arranged. J. W. Casey and L. E. Winter.
Properties of the virion, viral-host interactions, strategies for gene regulation, and mechanisms of pathogenicity are studied. Selected viral infections that result in immune disfunction and neoplasia are highlighted in the context of current approaches to prevent or reduce the severity of disease. Laboratories emphasize the isolation and culture of viral pathogens as well as demonstrations on tissue culture and animal models for studying the pathogenesis of, and the immune response to, infectious agents. Discussions are included in the laboratory and guest speakers present current approaches of identifying and characterizing viral agents.

[BIO S 317 Tissue Culture Techniques and Applications
Fall. 2 credits. Prerequisites: Biological Sciences 290 and 291 or permission of instructor. Not offered 1991–92.
Lec, F 1:25–2:30; lab exercises with follow-up work done independently, F 2:30–4:30. C. M. Rehkugler.
A series of lectures and demonstrations dealing with cell culture methods especially those required to culture cells of animals from different tissue origins. The application of cell culture to the study of bacterial diseases, virus replication, and the production of biologicals is considered.]

[BIO S 398 Environmental Microbiology (also SCAS 398)
Spring. 3 credits. Prerequisites: Biological Sciences 261 or 290 or Soil, Crop, and Atmospheric Sciences 260 or permission of instructor. Offered alternate years. Not offered 1991–92.
Lecs, M W F 10:10. M. Alexander and W. C. Ghiorse.
Behavior and function of microorganisms in natural environments and the role of microorganisms in transformation of pollutants.]

BIO S 406 Clinical Microbiology
Fall or spring. Credit to be arranged. Prerequisite: permission of instructor.
Hours to be arranged. R. P. Mortlock.
Training and practical experience in clinical microbiology in the hospital laboratory of the Cornell Medical College and New York Hospital in New York City. Emphasis is on developing students' capability in the isolation and rapid identification of organisms from various types of clinical specimens. This course is intended to prepare the student for state and federal licensing in various areas of clinical microbiology.

BIO S 415 Bacterial Diversity, Lectures
Fall. 3 credits. Prerequisites: Biological Sciences 290 and 291 and 330 or 331. May be taken without Biological Sciences 417.
Lecs, M W F 11:15. S. H. Zinder.
A consideration of the physiology, ecology, genetics, and practical potential of important groups of bacteria. Topics include molecular methods for determining bacterial phylogeny and taxonomy, the evolution of diverse mechanisms of energy conservation, fixation of carbon and nitrogen, and adaptation to extreme environments.

BIO S 416 Microbial Physiology, Lectures
Spring. 3 credits. Prerequisites: Biological Sciences 290 and 291 or equivalent and biochemistry. Biological Sciences 415 recommended. S-U grades optional for students not specializing in the microbiology program of study.
Lecs, M W F 11:15. R. P. Mortlock.
The concern is with the physiological functions of microorganisms. Consideration is given to chemical structure, regulation, growth, and the energy metabolism of prokaryotic organisms. Special attention given to those aspects of microbial metabolism and carbohydrate catabolism not normally studied closely in biochemistry courses.

BIO S 417 Bacterial Diversity, Laboratory
Fall. 2 credits. Prerequisites: Biological Sciences 415 (may be taken concurrently) and permission of instructor.
Lab, M W 2–4:25. S. H. Zinder.
Intended as a laboratory complementing Biological Sciences 415. The enrichment, isolation, characterization, and study of bacteria included in Biological Sciences 415.

BIO S 418 Microbial Physiology, Laboratory
Spring. 3 credits. Limited to 12 students. Prerequisites: Biological Sciences 416 (may be taken concurrently) and permission of instructor. S-U grades optional.
Lab, T R 12:20–4:25. R. P. Mortlock.
The laboratory component of Biological Sciences 416. Deals with laboratory experiments and techniques used in studying the enzymology and physiological characteristics of microorganisms.

[BIO S 451 Structure and Function of Bacterial Cells
Fall. 3 credits. Prerequisites: Biological Sciences 290 and 330 or 331 or permission of instructor. Biological Sciences 415 recommended. S-U grades optional. Offered alternate years. Not offered 1991–92.
Lecs, M W F 10:10. W. C. Ghiorse.
Morphology, ultrastructure, macromolecular organization and life cycles of bacterial cells are considered with regard to chemical composition and physiological and ecological function of cellular components.]

[BIO S 453 Bacterial Cytology Laboratory
Fall. 1 or 2 credits. Enrollment limited. Prerequisites: Biological Sciences 451 or concurrent enrollment, and permission of instructor. Offered alternate years. Not offered 1991–92.
Lab, hours to be arranged. W. C. Ghiorse.
Theory and proper use of light and electron microscopes; cytological and cytochemical techniques for light and electron microscopy that are applicable to the study of bacterial structure and function.]

BIO S 652 (section 04) Molecular Plant-Microbe Interactions
Spring. 1 credit. Prerequisites: Biological Sciences 281, 330 or 331, and 653 (section 01) or their equivalents. S-U grades optional.
M W F 10:10 (12 lectures, Mar. 25–Apr. 20). S. C. Winans, T. A. LaRue.
Course focuses on the interactions of *Agrobacteria* and *Rhizobia* with plants. Topics on *Agrobacterium*-plant interactions include plant-microbe recognition mechanisms, T-DNA transfer process, oncogenesis, and use of *Agrobacterium* to produce transgenic plants. Topics on *Rhizobium*-plant interactions include regulation of nitrogenase activity and expression, organization and function of the *sym* plasmid, nodule development, and plant genetics involved in plant-microbe interaction.

BIO S 692 Protein-Nucleic Acid Interactions
Spring. 3 credits. Prerequisites: Biological Sciences 330 or 331 and 633.
Lecs, T R 10:10–11:25. J. D. Helmann.
The physical and chemical bases of protein-nucleic acid interactions are explored including both theory and specific examples. Proteins considered include: bacterial non-specific and sequence specific DNA and RNA binding proteins, nucleic acid polymerases, recombinases, topoisomerases, DNA repair enzymes, and nucleases.

BIO S 694 Genetic Aspects of Bacterial Diversity
Spring. 3 credits. Prerequisite: Biological Sciences 485 or equivalent.
Lecs, M W 2:30–3:45. S. C. Winans.
Selected topics in bacterial diversity, with strong emphasis placed on underlying molecular mechanisms. Topics include interactions between bacteria and plants and animals, prokaryotic developmental biology, biodegradation of xenobiotics, and synthesis of antibiotics.

BIO S 695 Bacterial Genetics
Fall. 3 credits. Prerequisites: Biological Sciences 485 and 633 or permission of instructor.
Lecs, T R 10:10–11:25. V. J. Stewart.
Current themes in bacterial genetics are considered in detail through examination of the primary literature. Topics include: recombination and genetic exchange; transposons; mutagenesis and DNA repair; and pathway-specific and global regulation of gene expression. Emphasis is on coordinated studies that derive complementary information from both *in vivo* and *in vitro* techniques.

BIO S 696 Advanced Bacterial Genetics
Offered by special arrangement; see instructor. 2 credits. Prerequisites: Biological Sciences 281 and 291, and written permission of instructor. Corequisite: Biological Sciences 485 or 695.
Hours to be arranged. V. J. Stewart.
Theory and practice of prokaryotic genetics as applied to *Salmonella typhimurium*. Topics include: isolating, characterizing, and mapping mutations; using transposons as mutagens and as linked selectable markers; constructing operon and gene fusions; and using selected recombinant DNA methods for gene isolation and analysis.

BIO S 705 Advanced Immunology Lectures (also Veterinary Microbiology 705)
Spring. 3 credits. Prerequisite: Biological Sciences 305 or permission of instructor. Offered alternate years.
Lecs, M W F 9:05. A. J. Winter, course coordinator.
Coverage at an advanced level of molecular and cellular immunology.

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

BIO S 797 Graduate Seminar in Microbiology
Fall and spring. 1 credit each semester. All students in the Graduate Field of Microbiology must enroll for at least their first three semesters in residence. Students are expected to lead discussions on recent primary literature in microbiology. S-U grades only.
Sem to be arranged. Staff.

BIO S 798 Graduate Research Seminar in Microbiology
Fall and spring. 1 credit each semester. Required of all graduate students in the Graduate Field of Microbiology; a seminar relating to the research activities of those enrolled. Students who have completed the Biological Sciences 797 series requirement are required to present a seminar concerning their research interests and activities at least once each year. S-U grades only.
Sem to be arranged. Staff.

BIO S 799 Microbiology Seminar
Fall and spring. Required of all graduate students in the Graduate Field of Microbiology and open to all who are interested.
Sem to be arranged. Staff.

Related Courses in Other Departments

Advanced Animal Virology, Lectures (Veterinary Medicine 708)

Advanced Food Microbiology (Food Science 607)

Advanced Soil Microbiology (Soil, Crop, and Atmospheric Sciences 666)

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

Algal Physiology (Biological Sciences 346)

Bacterial Plant Diseases (Plant Pathology 647)

Bioprocessing Applications in Agriculture (Agricultural and Biological Engineering 467)

Ciliophorology (Biological Sciences 409)

Comparative Biogeochemistry (Biological Sciences 668)

Controlled Cultivation of Microbial Cells (Chemical Engineering 646)

Ecology of Soil-Borne Pathogens (Plant Pathology 644)

Food Microbiology, Laboratory (Food Science 395)

Food Microbiology, Lectures (Food Science 394)

Food Mycology (Food Science 411)

Insect Pathology (Entomology 453)

Intermediate Soil Science: Chemistry and Microbiology (Soil, Crop, and Atmospheric Sciences 364)

Introduction to Bioprocess Engineering (Chemical Engineering 643)

Introduction to Scanning Electron Microscopy (Biological Sciences 401)

Introductory Mycology (Plant Pathology 309)

Limnology, Lectures (Biological Sciences 457)

Magical Mushrooms, Mischievous Molds (Plant Pathology 201)

Marine Microbial and Plankton Ecology (Biological Sciences 454 (formerly 306))

Marine Plankton Ecology (Biological Sciences 468)

Microbial Genetics, Laboratory (Biological Sciences 487)

Microbial Genetics, Lectures (Biological Sciences 485)

Microbiology of the Rumen (Animal Science 607)

Microbiology of Water and Wastewater (Civil and Environmental Engineering 651)

Optical Methods of Plant Biologist (Biological Sciences 450)

Plant Virology (Plant Pathology 645)

NEUROBIOLOGY AND BEHAVIOR

BIO S 221 Neurobiology and Behavior I: Introduction to Behavior
Fall. 3 or 4 credits (4 credits with discussion and written projects). 4–credit option required of students studying neurobiology and behavior. Each discussion limited to 20 students, with preference given to students studying neurobiology and behavior. Not open to freshmen. Prerequisite: one year of introductory biology for majors. May be taken independently of Biological Sciences 222. S-U grades optional.
Lecs, M W F 12:20; disc to be arranged. T. D. Seeley and staff.
A general introduction to the field of behavior. Topics include evolution and behavior, behavioral ecology, sociobiology, chemical ecology, communication, neuroethology, rhythmicity, orientation and navigation, and hormonal mechanisms of behavior.

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

BIO S 322 Hormones and Behavior (also Psychology 322)
Spring. 3 credits. Limited to juniors and seniors; open to sophomores only by permission. Prerequisites: one year of introductory biology plus a course in psychology or Biological Sciences 221 or 222. S-U grades optional.
Lecs, T R 10:10–11:30; disc to be arranged. E. Adkins Regan, R. E. Johnston.
The relationship between endocrine and neuroendocrine systems and the behavior of animals, including humans. Major emphasis is on sexual, parental, and aggressive behavior.

[BIO S 324 Biopsychology Laboratory (also Psychology 324)
Fall. 4 credits. Limited to 24 upperclass students. Prerequisites: laboratory experience in biology or psychology, Biological Sciences 221 and 222 or Psychology 123 and 222; and permission of instructor. Not offered 1991–92.
Labs, T R 1:25–4:25. T. J. DeVoogd.
Experiments designed to provide research experience in animal behavior (including learning) and its neural and hormonal mechanisms. A variety of techniques, species, and behavior patterns are included. Live animals are used in the laboratory.]

BIO S 326 The Visual System
Spring. 4 credits. Prerequisites: Biological Sciences 222 or 311, or permission of instructor. S-U grades optional. Offered alternate years.
Lecs, M W F 10:10; disc, 1 hour each week to be arranged. H. C. Howland.
The visual systems of vertebrates and invertebrates are discussed in breadth and depth. Topics covered include the optics of eyes, retinal neurophysiology, structure and function of higher visual centers, and ocular development.

BIO S 328 Biopsychology of Learning and Memory (also Psychology 332) (formerly Biological Sciences 332)
Spring. 3 credits. Prerequisites: one year of biology and either a biopsychology class or Biological Sciences 222.
Lecs, M W F 11:15. T. J. DeVoogd.
This course surveys the approaches that have been or are currently being used to understand the biological bases for learning and memory. Topics include invertebrate, "simple system" approaches, imprinting, avian song learning, hippocampal and cerebellar function, and human pathology. Many of the readings are from primary literature.

BIO S 396 Introduction to Sensory Systems (also Psychology 396)
Spring. 3 or 4 credits (4 credits with discussion and term paper). No auditors. Prerequisites: an introductory course in biology or biopsychology, and a second course in neurobiology or behavior or perception or cognition or biopsychology; students are expected to have elementary knowledge of perception, neurophysiology, behavior, and chemistry. Permission of instructor required for 4–credit option. Offered alternate years.

Lecs, M W F 9:05. B. P. Halpern.

This course employs the Socratic method, in which the instructor asks questions of the students. Students read, analyze, and discuss in class difficult original literature dealing with both those characteristics of sensory systems that are common across living organisms and those sensory properties that represent adaptations of animals to particular habitats or environments. The principles and limitations of major methods used to examine sensory systems are considered. General principles of sensory systems and auditory, visual, and somesthetic systems are covered. One aspect of each system (e.g., localization of objects in space by sound, color vision, and thermoreception) is selected for special attention. At the level of *An Introduction to the Physiology of Hearing*, by J. O. Pickles; *Photoreceptors: Their Role in Vision*, by A. Fein and E. Z. Szuts; *Comparative Studies of Hearing in Vertebrates*, edited by A. N. Popper and R. R. Ray; and "Principles of Sensory Coding and Processing," edited by S. B. Laughlin. *Journal in Experimental Biology*, 146:1989.

BIO S 420 Topics in Neurobiology and Behavior
Fall or spring. Variable credit. May be repeated for credit. Primarily for undergraduates. S-U grades optional.

To be arranged. Staff.

Courses on selected topics in neurobiology and behavior; can include lecture and seminar courses. Topics, instructors, and time of organizational meetings are listed in the division's catalog supplement issued at the beginning of the semester.

BIO S 422 Computer Interfacing for Neurobiologists
Spring. 3 credits. Limited to 20 students. Prerequisites: Biological Sciences 222 and 426, or permission of instructor. S-U grades optional. Offered alternate years.

Lecs, T R 9:05; lab, 4 hours each week to be arranged. D. W. McBride.

Lectures and laboratories deal with interfacing a computer with an experiment and doing data acquisition and computer control of the experiment. Topics include introduction to digital electronics, data acquisition and monitoring of an experiment (A/D conversions and digital input), some data analysis and decision making, computer control of an experiment (D/A conversions and digital output), communication (RS-232 and IEEE), sampling theory and Fourier analysis and feedback control using computers. A Mac II computer is used in this course.

BIO S 424 Neuroethology
Fall. 3 credits. Prerequisites: Biological Sciences 221 and 222. S-U grades optional for graduate students only. Offered alternate years.

Lecs, M W F 11:15; occasional disc to be arranged. T. J. DeVoogd.

The integrated study of neurobiology and animal behavior. Representative topics include acoustic communication in insects and amphibians, vocal mechanisms and plasticity of bird song, mammalian hearing, bat echolocation, prey detection by owls, electroproduction and electroreception in fish, neurophysiology and behavior of pheromone communication, neurobehavior of vision in anurans, mammalian visual processing, command neurons and decision networks, locomotion and motor-pattern generation, escape behavior in invertebrates, and neural correlates of learning. Assigned readings include original articles in the scientific literature. A term paper on the neural basis of animal behavior is required.

[BIO S 426 Electronics for Neurobiology
Spring. 3 credits. Limited to 20 students. Prerequisites: Biological Sciences 222 and one year of introductory physics. Offered alternate years. Not offered 1991–92.

Lecs, T R 9:05; lab, 4 hours each week to be arranged. D. W. McBride.

The course deals with electronics as applied to neurobiology and behavior. Analog circuits centered around operational amplifiers are emphasized. Topics include a review of basic electrical concepts; the cell as circuit, voltage, and current amplifiers; transducers (temperature, light, pressure, etc.); filtering; timing circuits; radiotelemetry; basic trouble shooting; and reading schematics. In the last third of the term, students design and construct a circuit (both circuit board and housing box) of their own choosing relative to their research and/or interests.]

[BIO S 427 Animal Social Behavior
Fall. 4 credits. Limited to 30 students. Prerequisites: Biological Sciences 221 and 261 and permission of instructor. S-U grades optional, with permission of instructor. Offered alternate years. Not offered 1991–92.

Lecs and discs, M W 2:30–4:25. S. T. Emlen.

An intensive course for upper-division students interested in the adaptive bases of social behavior. Lectures, discussions, and student presentations examine topics including spacing systems, mating systems, sexual selection, mate choice, conflict and cooperation in animal societies, and the evolution of deceit, honesty, and altruism.]

BIO S 428 Topics in Behavior (formerly Mechanisms of Insect Behavior: Field and Laboratory Studies)
Fall or spring. 2–4 credits. (Credits based on number of lectures and/or field exercises as outlined in the division's catalog course supplement and subject to approval through the associate director's office.) May be repeated for credit. Primarily for undergraduates. S-U grades optional.

Sem to be arranged. Staff.

Courses on selected topics in behavior; can include lecture and seminar courses; may include laboratory. Past topics have included animal orientation, insect behavior, biorhythms, and communication. Topics, instructors, and time of organizational meeting are listed in the division's catalog supplement issued at the beginning of each semester.

[BIO S 429 Olfaction and Taste: Structure and Function (also Psychology 429)
Fall. 3 or 4 credits (4 credits with term paper on research project, which can, but need not, study nonhuman vertebrates). Prerequisite: a 300–level course in biopsychology or equivalent. Preference given to junior and senior psychology and biology majors and graduate students. S-U grades optional for graduate students only. Offered alternate years. Not offered 1991–92.

Lecs, T R 9:05. B. P. Halpern.

The structural and functional characteristics of olfaction and taste are explored by reading and discussing current literature in these areas. Structure is examined at the light- and electron-microscope levels, as well as at the molecular level. The neurophysiological and biochemical aspects of function are considered. The emphasis of the course is on vertebrates, especially air-breathing vertebrates in the case of olfaction, although there is some coverage of invertebrate forms.]

BIO S 491 Principles of Neurophysiology
Fall. 4 credits. Limited to 20 students. Prerequisite: Biological Sciences 222 or written permission of instructor. S-U grades optional for graduate students.

Lecs, M W 10:10; lab, M or W 12:20–4:25; additional hours to be arranged. B. R. Johnson.

A laboratory-oriented course designed to teach the theory and techniques of modern cellular neurophysiology. Lecture time is used to present laboratory exercise results, to supplement laboratory topics, and for discussion of primary research papers. Intracellular and extracellular recording techniques are used to analyze neuronal properties such as resting potentials, electrical and chemical synaptic transmission, ionic currents under voltage-clamp, and functional expression of foreign membrane proteins in *Xenopus oocytes*. A variety of preparations, both invertebrate and vertebrate, are used as model systems. Computer acquisition and analysis of laboratory results are emphasized.

[BIO S 492 Sensory Function (also Psychology 492)
Spring. 4 credits. Prerequisite: Biological Sciences 222 or 311 or an upper-level course in biopsychology, or permission of instructor. S-U grades optional. Offered alternate years. Not offered 1991–92.

Lecs, M W F 10:10; disc, 1 hour each week to be arranged. H. C. Howland, B. P. Halpern.

Classical topics in sensory function such as vision, hearing, touch, and balance, as well as some more modern topics, including sensory coding, location of stimulus sources in space, and the development of sensory systems. Both human and nonhuman systems are discussed. In all cases the chemical, physical, and neurophysiological bases of sensory information are treated and the processing of this information is followed into the central nervous system. At the level of *The Senses*, edited by Barlow and Mollon, and *An Introduction to the Physiology of Hearing*, by Pickles.]

[BIO S 493 Developmental Neurobiology
Fall. 3 credits. Prerequisite: Biological Sciences 222 or permission of instructor. S-U grades optional, with permission of instructor. Offered alternate years. Not offered 1991–92.
Lecs, M W F 9:05. R. Booker.
Lectures covering the development of the nervous system taking examples from both vertebrates and invertebrates. Emphasis is on cellular and molecular issues, that is, How do nerve cells differentiate both morphologically and biochemically? The role of cues such as hormones and developmental genes in neural development are discussed. Readings are taken from original journal articles.]

BIO S 494 Comparative Vertebrate Neuroanatomy
Spring. 3 credits. Intended for juniors, seniors, and graduate students. Prerequisite: Biological Sciences 222 or equivalent. S-U grades optional. Offered alternate years.
Lecs, T R 10:10–11:30. A. H. Bass.
Organization and evolution of neuroanatomical pathways as substrates for species-typical vertebrate behaviors. The course is divided into two major sections: principles of brain organization and vertebrate brain evolution.

[BIO S 495 Membrane Ion Channels
Spring. 3 credits. Limited to 15 students. Prerequisites: Biological Sciences 222, college introductory physics, and calculus, or permission of instructor. S-U grades optional. Offered alternate years. Not offered 1991–92.
Lecs, M W F 10:10. O. P. Hamill.
The functional and mechanistic aspects of membrane ion channels, beginning with basic concepts and model systems. Theories of ion permeation and channel gating are discussed. Development of membrane ion channels during neuron differentiation and the role of membrane channels in disease states are also considered.]

[BIO S 496 Bioacoustic Signals in Animals and Man
Spring. 3 credits. Limited to 12 junior, senior, and graduate students. Prerequisites: one year introductory biology, Physics 101–102 or 207–208, and permission of instructor required. S-U grades optional. Offered alternate years. Not offered 1991–92.
Lecs, M W 9:05; lab to be arranged.
C. Clark, R. R. Hoy.
Humans and most terrestrial animals live in a world of sound. Acoustic signals mediate social interactions and predator-prey behavior. This course teaches students about animal acoustical communication by introducing them to the different communication systems that are based on sound. The course presents the physical properties of sound, the physiological mechanisms of sound production and hearing, and an analysis of the behavioral context of signaling. In the laboratory students learn how to record, synthesize, and analyze acoustic signals with the aid of tape recorders and the Macintosh computer. Laboratories are designed around the lecture material and provide "real-world" exercises designed to stimulate discovery of the fundamental principles described in class. Class research projects on a selected topic in bioacoustics are required. The laboratory is based on software instrumentation running on a Macintosh II platform equipped with A/D-D/A data acquisition boards.]

[BIO S 497 Neurochemistry and Molecular Neurobiology
Fall. 3 credits. Limited to 30 students. Prerequisites: Biological Sciences 222 and either 330 or 331, or permission of instructor. S-U grades optional. Offered alternate years. Not offered 1991–92.
Lecs, T R 9:05; disc, T 10:10.
R. M. Harris-Warrick.
This course focuses primarily on synaptic neurochemistry. The presynaptic regulation of release and postsynaptic mechanism of action of the major classes of neurotransmitters are discussed, as well as selected neuromodulators and hormones. Second-messenger mechanisms are stressed. Readings are primarily from journal articles.]

BIO S 623 Chemical Communication (also Chemistry 622)
Fall. 3 credits. Primarily for research-oriented students. Limited to 30 students. Prerequisites: one year of introductory biology for majors or equivalent, course work in biochemistry, and Chemistry 358 or equivalent. Offered alternate years.
Lecs, M W F 1:25. T. Eisner, J. Meinwald, W. L. Roelofs, and guest speakers.
The production, transmission, and reception of chemical signals in communicative interactions of animals, plants, and microorganisms. Studies of insects are emphasized. Specific topics are treated with varying emphasis on chemical, biochemical, ecological, behavioral, and evolutionary principles.

[BIO S 626 Sex Differences in Brain and Behavior (also Psychology 524)
Spring. 2 credits. Limited to 12 students. Prerequisite: Biological Sciences 322 or permission of instructor. Not offered 1991–92.
Disc and sem, M W 3:35–5:30.
T. J. DeVoogd.
A survey of the newly discovered animal models for sex differences in the brain. Topics include the role of steroids in brain development, whether hormones can modify the structure of the adult brain, and the consequences of such sex differences in anatomy for behavior.]

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

BIO S 721 Introductory Graduate Survey in Neurobiology and Behavior (formerly Graduate Survey of Behavior and 722, Graduate Survey of Neurobiology)
Fall and spring. 2 credits each term. (Students must register for 4 credits each term, since an "R" grade is given at the end of the fall term.) Required of graduate students majoring in neurobiology and behavior. Concurrent registration in Biological Sciences 221 and 222 not required. S-U grades only.
Lecs and discs, T R 10:10–12:05, alternate weeks. Staff.
Lectures by faculty and student-led discussions on topics of current importance in neurobiology and behavior. Topics are linked to the materials presented in Biological Sciences 221 and 222. Class meets twice a week, every other week. Students are required to write four term papers, over the two semesters, on selected topics in two of three sub-areas: (1) cellular and molecular neurobiology; (2) integrative neurobiology; (3) behavior.

BIO S 723 Advanced Topics in Animal Behavior
Fall or spring. Variable credit. May be repeated for credit. Primarily for graduate students in behavior. Prerequisite: permission of instructor. S-U grades optional.
Sem to be arranged. Staff.
A seminar on a specific topic in animal behavior. The instructor presents lectures during the first few course meetings; the remainder of the course is devoted to student presentations. Topic and instructor are listed in the division's catalog supplement issued at the beginning of the semester.

BIO S 724 Field Methods in Animal Behavior
Fall or spring. Variable credit. May be repeated for credit. Primarily for graduate students in behavior. Prerequisite: permission of instructor. S-U grades optional.
Sem and fieldwork to be arranged. Staff.
A seminar-field experience course designed for first-year graduate students in animal behavior. Weekly seminars discussing field methodology, data collection, and hypothesis testing are followed by an intensive period (ten days to two weeks) in the field. Specific topics and field sites vary from semester to semester. Topic and instructor are listed in the division's catalog supplement issued at the beginning of the semester.

BIO S 790 Advanced Topics in Cellular and Molecular Neurobiology
Fall or spring. Variable credit. May be repeated for credit. Limited to graduate students and advanced undergraduates studying neurobiology and behavior. Prerequisite: Biological Sciences 222. S-U grades optional.
Lecs and sem to be arranged. Staff.
A lecture-seminar course on selected topics in cellular and molecular neurobiology. Students read original papers in the scientific literature and lead discussions of these articles. Suggestions for topics may be submitted by faculty or students to the chair of the Section of Neurobiology and Behavior. Topic and instructor are listed in the division's catalog supplement issued at the beginning of the semester.

BIO S 792 Advanced Laboratory in Cellular and Molecular Neurobiology
Fall or spring. 2 credits. May be repeated for credit. Primarily for graduate students. Prerequisites: Biological Sciences 330 or 331 or equivalent, 491 or equivalent, and written permission of instructor. S-U grades optional.
Lab to be arranged. Staff.
A two-week intensive laboratory course designed to provide experience with a specific technique currently used in cellular and molecular neurobiology. The technique under study and instructor in charge vary from semester to semester and are listed in the division's catalog supplement issued at the beginning of the semester.

BIO S 793 Advanced Topics in Integrative Neurobiology
Fall or spring. Variable credit. May be repeated for credit. Primarily for graduate students; written permission of instructor required for undergraduates. S-U grades optional.
Lecs and discs to be arranged. Staff.
A course designed to provide in-depth knowledge of current research in anatomical and physiological bases of vertebrate and invertebrate behavior. Readings are primarily from specialty books and selected journal articles. Topic and instructor are listed in the division's catalog supplement issued at the beginning of the semester.

BIO S 794 Advanced Laboratory Techniques in Integrative Neurobiology
Fall or spring. Variable credit. May be repeated for credit. Prerequisite: permission of instructor based upon a personal interview.
Lab to be arranged. Staff.
A laboratory in the integrative, or neuroethological, approach to studies of animal behavior. Designed to provide practical working knowledge of research methods in anatomical, physiological, and behavioral approaches to studies of vertebrate and invertebrate behavior. Laboratory technique to be covered and instructor are listed in the division's catalog supplement issued at the beginning of the semester.

Related Courses in Other Departments

Animal Behavior (Psychology 535)

Biochemistry and Human Behavior (Psychology 361 and Nutritional Sciences 361)

Brain and Behavior (Psychology 425)

Developmental Biopsychology (Psychology 422)

Evolution of Human Behavior (Psychology 326)

Human Behavior: A Sociobiological Perspective (Anthropology 476)

Insect Behavior Seminar (Entomology 662)

Primates and Evolution (Anthropology 490)

Primate Behavior and Ecology (Anthropology 390)

Teaching Experience (Biological Sciences 498)

Undergraduate Research in Biology (Biological Sciences 499)

SHOALS MARINE LABORATORY

John B. Heiser, director
G14 Stimson Hall, 255-3717

Seventy-two percent of the earth's surface is covered by the sea; knowledge of the sea is of paramount importance in understanding global environmental phenomena and change. The objective of the Shoals Marine laboratory (SML) is to provide undergraduates, beginning graduate students, and other interested adults a unique opportunity to explore marine sciences in an island setting noted for its biota, geology, and history. SML has established a national reputation for excellence and has become North America's largest marine field station focusing on undergraduate education.

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

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

Although there is no program of study in marine sciences offered to Cornell undergraduates, there is extensive opportunity at the undergraduate level to prepare for more advanced study.

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

The following marine sciences courses are currently administered by the Cornell Marine Programs Office.

BIO S 161 Introduction to Field Marine Science
Summer. 4 credits. S-U grades optional. A special 2-week course offered at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $1,395.
Daily lecs, labs, and fieldwork for 2 weeks. SML faculty.
This course allows students who are not biology majors to experience the breadth of the marine sciences under field conditions at an island laboratory. Aspects of biology, geology, earth science, chemistry, and physics are included. Specific topics include beach, salt marsh, tidal mud flat, tide pool, and benthic offshore environments; identification of marine plants and animals; chemical and physical oceanography; marine geology; and ecology of kelp beds and urchin barrens.

BIO S 204 Biological Illustration
Summer. 2 credits. A special 1-week course offered at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, supplies, and ferry transportation), $775.
Daily sessions for 1 week. SML faculty.
General discussion of scientific publishing, illustration labeling, color techniques, and printing processes. The course provides the scientist or science student a chance to experience several illustration techniques with the goal of obtaining an overview of scientific and wildlife illustrations. The student may choose a single technique to explore in depth. Course size is limited so that individual attention can be emphasized.

BIO S 309 Coastal Ecology and Bioclimates
Summer. 4 credits. Prerequisite: one year of college level biology; background preferred in physics/physical geography. S-U grades optional. A special 2-week course offered at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N.H. For more details and an application consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $1,295.
Daily lecs, labs, and fieldwork for 2 weeks. SML faculty.
A study of the fundamentals of organism-environment interaction developed through defining and measuring abiotic factors including solar radiation, temperature, atmospheric moisture, precipital wind, and currents. In-site exploration of the dynamics of meteorology and the role of abiotic and biotic factors in the life of coastal and marine plants and animals including humans.

BIO S 329 Ecology of Animal Behavior
Summer. 4 credits. Prerequisite: one year of introductory college biology. Recommended: course work in ecology, psychology, or behavior. S-U grades optional. A special 2-week course offered at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N. H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $1,295.

Daily lecs and fieldwork for 2 weeks. SML faculty.

The ecological significance of behaviors of coastal organisms, with emphasis on field and laboratory research methods. Lectures and readings address the major subareas of behavior (communication, orientation, social behavior, foraging, predator avoidance, and sensory mechanisms). Each student engages in short-term behavioral observation and prepares a research proposal for studying a problem within the course subject area.

BIO S 363 Marine Biology for Teachers
Summer. 3 credits. Primarily for teachers, grades 6 through 12, but open to others with teaching experience. Prerequisite: one year of introductory college biology. S-U grades optional. A special 10-day course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $975.

Daily lecs, labs, and fieldwork for 10 days. SML faculty.

Designed to give an overview of living marine organisms (algae, invertebrates, fishes, marine mammals, and shorebirds) and of the environment they inhabit. Fieldwork is emphasized. Occasional lectures and films deal with additional topics such as coastal-zone problems, marine fisheries, economics of marine organisms, and educational resources of the marine environment.

BIO S 364 Field Marine Science
Summer. 6 credits. Prerequisite: one year of college biology or other supporting subject. S-U grades optional. A special 4-week course offered twice each summer at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details and an application, consult the SML Office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $2,195.

Daily lecs, labs, and fieldwork for 4 weeks. 3 core faculty members assisted by up to 15 visiting lecturers, including representatives of governmental agencies and commercial fishermen. SML faculty.

Designed for the student who desires an initial overview of the marine sciences, this course emphasizes living material in natural habitats. Most of the course work is concerned with the biology of intertidal plants and animals, biological oceanography, ichthyology, and fisheries. Attention is also given to introductory physical and chemical oceanography and marine geology. Marine ecology and the effects of human activity on the marine environment are included. Students apply this knowledge by conducting a transect study toward the end of the course.

BIO S 365 Underwater Research
Summer. 4 credits. Prerequisites: one year of college-level biology or other supporting subject, recognized scuba certification, and a medical examination. S-U grades optional. A special 2-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $1,400.

Daily lecs and fieldwork for 2 weeks. Team-taught by a diving-safety officer, two faculty members, and guest lecturers.

For competent divers only. Covers special problems of underwater research, including random sampling, use of dive tables, underwater instrumentation, special diving equipment, photographic techniques, integration with boat and shore facilities, and emergency procedures. Students are required to conduct a transect study on both soft and hard substrates.

BIO S 366–370 SEA Semester
In cooperation with the Sea Education Association (SEA), the Shoals Marine Laboratory office offers a semester-length sequence of courses designed to provide college undergraduates with a thorough academic, scientific, and practical understanding of the sea. *This sequence is repeated approximately once every two months throughout the year.* Students spend the first half of SEA Semester (the six-week shore component) in Woods Hole, Massachusetts, receiving instruction in oceanography, nautical science, and maritime studies. The second half of SEA Semester (the six-week sea component) is spent at sea aboard the R/V *Westward* or the R/V *Corwith Cramer.* Enrollment is open to men and women judged capable of benefiting from SEA Semester; no specific prior training or study is required. Cornell students enrolled in the SEA Semester must take the entire sequence.

For more information, consult the Shoals Marine Laboratory office, G14 Stimson Hall, or call SEA directly at 1-800-552-3633. Program costs are to be paid in place of regular Cornell tuition and fees: tuition for entire 17-credit SEA Semester, about $8,800; room and board for sea component (six weeks) only, about $1,875.

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

Shore Component (six weeks)

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

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

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

Sea Component (six weeks)
Courses 369 and 370 take place aboard the R/V *Westward*, a 125-foot steel auxiliary-powered staysail schooner built in 1961, or the R/V *Corwith Cramer*, a 134-foot steel auxiliary-powered brigantine built in 1987 for SEA. Both ships normally put to sea with a ship's company of thirty-four. The professional staff of nine includes the captain, the chief scientist, three science watch officers, three deck watch officers, an engineer, and a steward. In addition, one or more visiting investigators are frequently aboard. Up to twenty-five students round out the complement.

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

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

BIO S 402 Marine Pollution
Summer. 4 credits. Prerequisite: one year college-level biology and chemistry or permission of instructor. S-U grade optional. A special 2-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $1,295.

Daily lecs, labs, and fieldwork for 2 weeks. SML faculty.

Dispersion modeling and the effects of pollutants (including oil, outfalls, solid wastes, sludge and dredge spoils, and radioactive wastes) are discussed from the perspectives of elementary physical oceanography and biological processes. Laboratories include basic methods for targeting and tracing wastewater, organic carbon determinations, and practical field projects.

BIO S 409 Ciliophorology
Summer. 2 credits. Prerequisite: permission of instructor. A special 1-week course offered at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $725.

Daily lecs and labs for 1 week. SML faculty.

A special course that examines ciliophoran biology in depth through lectures and laboratory exercises. Topics include a detailed look at the ciliate faunules found in such diverse habitats as saltmarshes, sandy sediment interstitial spaces, the Gulf Stream and the Sargasso Sea, marine caves, and benthic hydrothermal vents. Laboratory focuses on examining silver stained specimens, and covers staining techniques, as well as back scattered and secondary SEM and TEM methodologies.

BIO S 413 Adaptations of Marine Organisms
Summer. 6 credits. Prerequisite: Biological Sciences 364 or a course in physiological ecology. S-U grades optional. A special 3-week course offered at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $1,795.

Daily lecs, labs, and fieldwork for 3 weeks. SML faculty.

An introduction to the physiological ecology and functional morphology of marine plants and animals, with emphasis on selected algal and invertebrate examples from the Gulf of Maine. Topics covered include photosynthesis in the marine environment; respiration in intertidal organisms; carbohydrates, proteins, and lipids as nutrients in the sea; acclimation and tolerance of tide-pool biota; and biological responses to competition and grazing. Field and laboratory exercises explore principles and procedures used to characterize the physical, chemical, and biotic environment of intertidal and shallow subtidal organisms, including determination of temperature, light, salinity, oxygen and nutrient levels, and *in vivo* functional analyses of metabolic phenomena.

BIO S 449 Marine Botany: Ecology of Marine Plants
Summer. 4 credits. Prerequisite: Biological Sciences 364 or general familiarity with marine algae. S-U grades optional. A special 2-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $1,295.

Daily lecs, labs, and fieldwork for 2 weeks. SML faculty.

An overview of the major marine algal groups, including aspects of anatomy, morphology, development, life histories, physiology, and use. Laboratories and fieldwork emphasize relationships between distribution and major environmental parameters and involve student projects.

BIO S 454 Marine Microbial and Plankton Ecology (formerly Biological Sciences 306)
Summer. 4 credits. Prerequisites: one year each of introductory college biology and chemistry. S-U grades optional. A special 2-week course offered at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $1,295.

Daily lecs, labs, and fieldwork for 2 weeks. SML faculty.

A lecture, field, and laboratory course which examines the plethora of single-celled organisms, including bacteria, unicellular algae, fungi, heterotrophic/mixotrophic flagellates, amoebae, ciliates and multicellular planktonic organisms (coelenterates, crustaceans, ctenophores, chaetognaths, tunicates, and larvae of assorted benthic invertebrates) that make the marine environment their home. The course emphasizes the role of these organisms in marine food webs and their importance to biological oceanographic processes.

[BIO S 468 Marine Plankton Ecology
Summer. 4 credits. Limited to 20 students. Prerequisites: one year of introductory college biology and Biological Sciences 364 or equivalent, or a course in invertebrate zoology or introductory oceanography. S-U grades optional. A special course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $1,295. Not offered summer 1991.

Daily lecs, labs, and fieldwork for 2 weeks. SML faculty.

An introduction to the biology of plankton and their ecological role in representative marine environments, including estuaries, coastal areas, open ocean gyres, and polar seas. Includes an overview of morphology, life histories, and nutrition of planktonic bacteria, protozoans, algae, and metazoans (coelenterates, crustaceans, ctenophores, chaetognaths, and tunicates). The role of these groups in different ecosystems is related to the hydrography of the area, as well as the life cycles and trophic interactions of the dominant species. During several one-day cruises in the Gulf of Maine and Great Bay Estuary students use simple field techniques to address current research problems.]

BIO S 477 Marine Vertebrates
Summer. 6 credits. Prerequisite: Biological Sciences 364 or 274 or a course in vertebrate biology. S-U grades optional. A special 3-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $1,795.

Daily lecs, labs, and fieldwork for 3 weeks. SML faculty.

Topics in marine vertebrate biology emphasizing laboratory studies, field collections or observations, and readings from the current literature. Topics covered include systematics of fishes of the Gulf of Maine, elasmobranch physiology, interpretation of life history and parameters from otolith microstructure, teleost skeletomuscular structure and function, population biology and the contemporary Gulf of Maine fishery, Mesozoic marine reptiles, the biology of sea turtles in cold water, coloniality in sea birds, avian adaptations to life at sea, evolution and systematics of marine mammals, diving physiology, and ecology and conservation of existing marine mammal populations. Dissection of vertebrate animals is a part of one or more laboratory sessions.

ARKEO Archaeology of Maritime Communities (Archaeology 300: Individual Study in Archaeology)
Summer. 2 credits. Prerequisite: a strong interest in history or permission of instructor. A special 1-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $725.

Daily lecs, labs, and fieldwork for 1 week. SML faculty.

Fieldwork on various land sites and their adjacent offshore marine environments. Artifact analysis, preliminary conservation, and the proper recording of finds are emphasized. Methods of archaeological research, including the use of archives and historical materials, and publication methodologies as well as the larger questions in the discipline are discussed.

NTRES Coastal and Oceanic Law and Policy (Natural Resources 306)
Summer. 2 credits. A special 1-week course offered at Cornell's Shoals Marine Laboratory (SML) on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $725.

Daily lecs and discs for 1 week. SML faculty.

Intended for persons interested in careers in management of marine or coastal resources or in the natural sciences. Subjects include law and policy related to ocean dumping, marine sanctuaries, environmental impact statements, water and air pollution, fisheries management, offshore gas and oil production, and territorial jurisdiction. Lectures on the status and history of law are accompanied by discussion of relevant policy and analysis of the efficacy of various legal techniques. A case study that requires extensive use of the laboratory's library and personnel is assigned. The week concludes with a mock hearing.

GEOL Marine and Coastal Geology (Geological Sciences 213)
Summer. 2 credits. Prerequisite: an introductory course in geology or permission of instructor. A special 1-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $725.

Daily lecs, labs, and fieldwork for 1-week. SML faculty.

With "the New England coast" defined as beginning at the -200 meter isobath and proceeding westward, this course examines specific geological events and processes important in shaping the area's bedrock and surficial sediments. Petrology, geophysics, and the Pleistocene geology of the region are investigated. Consideration of the geologic history of New England within the plate tectonic model is emphasized. Examination of insular geology is used to integrate micro-, meso-, and macroscale geological evolution of continental margins in general. Marine geology is approached through basic geophysical exploration and bottom-sediment collection followed by data analysis and interpretation. Experience aboard a coastal research vessel is an integral part of the course.

ARKEO Archaeology Underwater (Archaeology 319)
Summer. 2 credits. Prerequisites: recognized scuba certification and a medical examination required for students engaging in underwater research; also open to non-divers. A special 1-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $825.

Daily lecs, labs, and fieldwork for 1 week. SML faculty.

An introduction to the subject and a review of this contemporary subdiscipline of archaeology. The approach of the course is practical, with a strong potential for actual on-site experience in search, site recognition, survey, and recording. The course also covers the history and development of the subject, the legal aspects of underwater research, and the worldwide potential of the field. Since any archaeological research project involves a great deal more than digging, the course provides ample opportunities for those who are interested in the subject but are not divers or sufficiently experienced in scuba.

NTRES Wetland Resources (Natural Resources 417)
Summer. 2 credits. Prerequisite: one year of college biology. A special 1-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $725.

Daily lecs, labs, and fieldwork for 1 week. SML faculty.

An examination of coastal and adjacent freshwater wetlands from historic, destruction, and preservation perspectives, including fresh- and salt-marsh ecology and management. Field trips to selected examples of the wetlands under discussion and follow-up laboratories emphasize successional features, plant identification and classification, and examination of the dominant insect and vertebrate associations.

AGEC The History and Economics of Whaling in North America (Agricultural Economics 454 and History 413)
Summer. 2 credits. A special 2-week course offered at Cornell's Shoals Marine Laboratory (SML), on an island off Portsmouth, N.H. For more details and an application, consult the SML office, G14 Stimson Hall. Estimated cost (includes tuition, room and board, and ferry transportation), $675.

Daily lecs, labs, and fieldwork for 2 weeks. D. H. Usner, J. M. Conrad.

The whaling industry of nineteenth-century Americn presents a rich tapestry for studying the people, resources, and technology that contributed to the economic development of the United States. This course examines the species of whales on which that industry was based, aboriginal and colonial whaling, the golden era of the American fishery, whaling in the western Arctic, and the decline and demise of the industry in the early twentieth century. Social relationships, cross-cultural influences, markets, resource dynamics, and technical change are all evident in the rise and fall of this unique American industry.

COURSES IN BIOPHYSICS

Biophysics is an interdisciplinary undergraduate and graduate program. A special program for undergraduate students interested in biophysics is offered as an independent program of study in the biological sciences major (see option 10 under "Programs of Study"). Information on this independent option is available in the Office for Academic Affairs, 200 Stimson Hall. Graduate study and research in biophysics are available through several Graduate Fields. Students interested in graduate work in biophysics should inquire at the Program in Biophysics Office, 210 Clark Hall.

The following courses are available for students interested in biophysics:

Biomechanical Systems—Analysis and Design (Mechanical and Aerospace Engineering 565)

Chemistry of Nucleic Acids (Chemistry 677)

Computer Interfacing for Neurobiologists (Biological Sciences 422)

Electron Microscopy for Biologists (Biological Sciences 401, 403, 405, 606, 608)

Electronics for Neurobiology (Biological Sciences 426)

Enzyme Catalysis and Regulation (Chemistry 672)

Membrane Biophysics (Applied and Engineering Physics 615)

Membranes and Bioenergetics (Biological Sciences 632)

Membrane Ion Channels (Biological Sciences 495)

Neurochemistry and Molecular Neurobiology (Biological Sciences 497)

Neuroethology (Biological Sciences 424)

Photosynthesis (Biological Sciences 445)

Physical Chemistry of Proteins (Chemistry 686)

Principles of Neurophysiology (Biological Sciences 491)

Protein Structure and Function (Biological Sciences 631)

Special Topics in Biophysical and Bioorganic Chemistry (Chemistry 782)

Transport of Solutes and Water in Plants (Biological Sciences 649)

FACULTY ROSTER

New York State College of Agriculture and Life Sciences

Adler, Kraig K., Ph.D., U. of Michigan. Prof., Neurobiology and Behavior
Barker, Robert, Ph.D., U. of California at Berkeley. Prof., Biochemistry, Molecular and Cell Biology/Center for the Environment
Bates, David M., Ph.D., U. of California at Los Angeles. Prof., Bailey Hortorium
Beyenbach, Klaus W., Ph.D., Washington State U. Prof., Physiology/Veterinary Physiology†
Bruns, Peter J., Ph.D., U. of Illinois. Prof., Genetics and Development
Calvo, Joseph M., Ph.D., Washington State U. William T. Keeton Professor in Biological Sciences; Biochemistry, Molecular and Cell Biology
Chabot, Brian F., Ph.D., Duke U. Prof., Ecology and Systematics
Crepet, William L., Ph.D., Yale U. Prof., Bailey Hortorium
Davies, Peter J., Ph.D., U. of Reading (England). Prof., Plant Biology
Davis, Jerrold I., Ph.D., U. of Washington. Asst. Prof., Bailey Hortorium
Doyle, Jeffrey J., Ph.D., Indiana U. Assoc. Prof., Bailey Hortorium
Eisner, Thomas, Ph.D., Harvard U. Jacob Gould Schurman Professor, Neurobiology and Behavior
Emlen, Stephen T., Ph.D., U. of Michigan. Prof., Neurobiology and Behavior
Feeny, Paul P., Ph.D., Oxford U. (England). Prof., Ecology and Systematics/Entomology
Fox, Thomas D., Ph.D., Harvard U. Assoc. Prof., Genetics and Development
Ghiorse, William C., Ph.D. Rensselaer Polytechnic Inst. Assoc. Prof., Microbiology
Gibson, Jane, Ph.D., U. of London (England). Prof., Biochemistry, Molecular and Cell Biology
Goldberg, Michael L., Ph.D., Stanford U. Assoc. Prof., Genetics and Development
Hanson, Maureen R., Ph.D., Harvard U. Assoc. Prof., Genetics and Development
Harrison, Richard G., Ph.D., Cornell U. Prof., Ecology and Systematics
Harris-Warrick, Ronald M., Ph.D., Stanford U. Assoc. Prof., Neurobiology and Behavior
Harvell, C. Drew, Ph.D., U. of Washington. Asst. Prof., Ecology and Systematics
Helmann, John D., Ph.D., U. of California at Berkeley. Asst. Prof., Microbiology
Hopkins, Carl D., Ph.D., Rockefeller U. Prof., Neurobiology and Behavior

Jagendorf, Andre T., Ph.D., Yale U. Liberty Hyde Bailey Professor of Plant Physiology, Plant Biology*
Keller, Elizabeth B., Ph.D., Cornell U. Prof., Biochemistry, Molecular and Cell Biology
Kemphues, Kenneth J., Ph.D., Indiana U. Assoc. Prof., Genetics and Development
Lis, John T., Ph.D., Brandeis U. Assoc. Prof., Biochemistry, Molecular and Cell Biology
Loew, Ellis R., Ph.D., U. of California at Los Angeles. Assoc. Prof., Physiology/Veterinary Physiology†
Luckow, Melissa A., Ph.D., U. of Texas at Austin. Asst. Prof., Bailey Hortorium
McCune, Amy R., Ph.D., Yale U. Assoc. Prof., Ecology and Systematics
MacIntyre, Ross J., Ph.D., Johns Hopkins U. Prof., Genetics and Development
Marks, Peter L., Ph.D., Yale U. Prof., Ecology and Systematics
Mortlock, Robert P., Ph.D., U. of Illinois. Prof., Microbiology
Nasrallah, June B., Ph.D., Cornell U. Assoc. Prof., Plant Biology
Niklas, Karl J., Ph.D., U. of Illinois. Prof., Plant Biology
Nixon, Kevin C., Ph.D., U. of Texas at Austin. Asst. Prof., Bailey Hortorium
Owens, Thomas G., Ph.D., Cornell U. Asst. Prof., Plant Biology
Paolillo, Dominick J., Jr., Ph.D., U. of California at Davis. Prof., Plant Biology
Parthasarathy, Mandayam V., Ph.D., Cornell U. Prof., Plant Biology
Pough, F. Harvey, Ph.D., U. of California at Los Angeles. Prof., Ecology and Systematics/Physiology
Quaroni, Andrea, Ph.D., U. of Pavia (Italy). Asst. Prof., Physiology
Roberts, Jeffrey W., Ph.D., Harvard U. Prof., Biochemistry, Molecular and Cell Biology*
Root, Richard B., Ph.D., U. of California at Berkeley. Prof., Ecology and Systematics/Entomology
Russell, James B., Ph.D., U. of California at Davis. Assoc. Prof., Microbiology
Shalloway, David I., Ph.D., Massachusetts Inst. of Technology. Prof., Biochemistry, Molecular and Cell Biology
Spanswick, Roger M., Ph.D., U. of Edinburgh (Scotland). Prof., Plant Biology
Stewart, Valley J., Ph.D., U. of Virginia. Asst. Prof., Microbiology
Tye, Bik-Kwoon, Ph.D., Massachusetts Inst. of Technology. Assoc. Prof., Biochemistry, Molecular and Cell Biology
Vogt, Volker M., Ph.D., Harvard U. Assoc. Prof., Biochemistry, Molecular and Cell Biology
Walcott, Charles, Ph.D., Cornell U. Prof., Neurobiology and Behavior/Laboratory of Ornithology
Wayne, Randy O., Ph.D., U. of Massachusetts. Asst. Prof., Plant Biology
Winans, Stephen C., Ph.D., Massachusetts Inst. of Technology. Asst. Prof., Microbiology
Winkler, David W., Ph.D., U. of California at Berkeley. Asst. Prof., Ecology and Systematics
Wu, Ray, Ph.D., U. of Pennsylvania. Prof., Biochemistry, Molecular and Cell Biology
Zahler, Stanley A., Ph.D., U. of Chicago. Prof., Genetics and Development*
Zinder, Stephen H., Ph.D., U. of Wisconsin. Assoc. Prof., Microbiology

Other Teaching Personnel

Alexander, Renee R., Ph.D., Cornell U. Sr. Lecturer, Biochemistry, Molecular and Cell Biology
Cordts, Marcia L., Ph.D., Cornell U. Sr. Lecturer, Microbiology
Ecklund, P. Richard, Ph.D., Oregon State U. Lecturer, Neurobiology and Behavior
Ferger, Martha F., Ph.D., Cornell U. Medical College. Sr. Lecturer, Biochemistry, Molecular and Cell Biology
Glase, Jon C., Ph.D., Cornell U. Sr. Lecturer, Neurobiology and Behavior
Griffiths, Joan M., Ph.D., Cornell U. Lecturer, Biochemistry, Molecular and Cell Biology
Heiser, John B., Ph.D., Cornell U. Sr. Lecturer, Ecology and Systematics
McFadden, Carol H., Ph.D., Cornell U. Sr. Lecturer, Physiology
Huntley, Anthony C., Ph.D., U. of California at Santa Cruz. Instructor, Ecology and Systematics
Rehkugler, Carole M., M.S., Cornell U. Sr. Lecturer, Microbiology
Reiss, H. Carol, M.S., Cornell U. Sr. Lecturer, Plant Biology

Joint Appointees

Bloom, Stephen E., Assoc. Prof., Poultry and Avian Sciences/Biological Sciences
Borror, Arthur C., Adjunct Prof., U. of New Hampshire/Biological Sciences
Brown, William L., Jr., Prof., Entomology/Ecology and Systematics
Butler, Walter R., Assoc. Prof., Animal Science/Physiology
Currie, W. Bruce, Assoc. Prof., Animal Science/Physiology
Edelstein, Stuart M., Adjunct Prof., U. of Geneva (Switzerland)/Biochemistry, Molecular and Cell Biology
Foote, Robert H., Jacob Gould Schurman Professor, Animal Science/Physiology
Howell, Stephen H., Adjunct Prof., Boyce Thompson Institute/Plant Biology
Kochian, Leon V., Adjunct Asst. Prof., USDA Science and Education Administration/Plant Biology
Korf, Richard P., Prof., Plant Pathology/Bailey Hortorium
LaRue, Thomas A., Adjunct Prof., Boyce Thompson Institute/Plant Biology
Last, Robert L., Adjunct Asst. Prof., Boyce Thompson Institute/Genetics and Development
Leopold, A. Carl, Adjunct Prof., Boyce Thompson Institute/Plant Biology
McCarty, Richard E., Adjunct Prof., Johns Hopkins U. Biochemistry, Molecular and Cell Biology
Moffat, J. Keith, Adjunct Prof., U. of Chicago/Biochemistry, Molecular and Cell Biology
Pimentel, David, Prof., Entomology/Ecology and Systematics
Richmond, Milo E., Assoc. Prof., USDI Fish and Wildlife Service/Natural Resources/Ecology and Systematics
Rossman, Michael J., Adjunct Prof., Purdue U./Biochemistry, Molecular and Cell Biology
Stern, David B., Adjunct Asst. Prof., Boyce Thompson Institute/Plant Biology
Thompson, John F., Adjunct Prof., USDA Science and Education Administration/Plant Biology
Via, Sara, Assoc. Prof., Entomology/Ecology and Systematics
Weeden, Norman F., Assoc. Prof., Horticultural Sciences/Bailey Hortorium
Wheeler, Quentin D., Assoc. Prof., Entomology/Bailey Hortorium

College of Arts and Sciences

Aquadro, Charles F., Ph.D., U. of Georgia. Assoc. Prof., Genetics and Development/Ecology and Systematics
Bass, Andrew H., Ph.D., U. of Michigan. Assoc. Prof., Neurobiology and Behavior
Blackler, Antonie W., Ph.D., U. of London (England). Prof., Genetics and Development
Booker, Ronald, Ph.D., Princeton U. Asst. Prof., Neurobiology and Behavior
Bretscher, Anthony P., Ph.D., Leeds U. (England). Assoc. Prof., Biochemistry, Molecular and Cell Biology
Brown, William J., Ph.D., U. of Texas Health Science Center at Dallas. Asst. Prof., Biochemistry, Molecular and Cell Biology
Capranica, Robert R., Sc.D., Massachusetts Inst. of Technology. Prof., Neurobiology and Behavior
Dawson, Todd E., Ph.D., U. of Washington. Asst. Prof., Ecology and Systematics
Feigenson, Gerald W., Ph.D., California Inst. of Technology. Prof., Biochemistry, Molecular and Cell Biology
Geber, Monica A., Ph.D., U. of Utah. Asst. Prof., Ecology and Systematics
Gibson, Quentin H., Ph.D./D.Sc., Queen's U. (Northern Ireland). Greater Philadelphia Professor in Biological Sciences; Biochemistry, Molecular and Cell Biology
Hairston, Nelson G., Jr., Ph.D., U. of Washington. Prof., Ecology and Systematics
Halpern, Bruce P., Ph.D., Brown U. Prof., Neurobiology and Behavior/Psychology
Hamill, Owen P., Ph.D., U. of New South Wales (Australia). Asst. Prof., Neurobiology and Behavior
Heppel, Leon A., Ph.D., U. of California at Berkeley. Prof., Biochemistry, Molecular and Cell Biology
Hess, George P., Ph.D., U. of California at Berkeley. Prof., Biochemistry, Molecular and Cell Biology
Hinkle, Peter C., Ph.D., New York U. Prof., Biochemistry, Molecular and Cell Biology
Howarth, Robert W., Ph.D., Massachusetts Inst. of Technology/Woods Hole Oceanographic Institution. Prof., Ecology and Systematics
Howland, Howard C., Ph.D., Cornell U. Prof., Neurobiology and Behavior/Physiology
Hoy, Ronald R., Ph.D., Stanford U. Prof., Neurobiology and Behavior‡
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Karplus, P. Andrew, Ph.D., U. of Washington. Asst. Prof., Biochemistry, Molecular and Cell Biology
Kennedy, Kenneth A.R., Ph.D., U. of California at Berkeley. Prof., Ecology and Systematics
Levin, Simon A., Ph.D., U. of Maryland at College Park. Charles A. Alexander Professor of Biological Sciences; Ecology and Systematics‡
McClearn, Deedra K., Ph.D., Harvard U. Asst. Prof., Ecology and Systematics
MacDonald, June M. Fessenden, Ph.D., Tufts U. Assoc. Prof., Biochemistry, Molecular and Cell Biology/Program on Science, Technology, and Society
Mark, Willie H., Ph.D., U. of Wisconsin—Madison. Asst. Prof., Genetics and Development
Podleski, Thomas R., Ph.D., Columbia U. Prof., Neurobiology and Behavior‡

Power, Alison G., Ph.D., U. of Washington. Asst. Prof., Ecology and Systematics/Program on Science, Technology, and Society
Provine, William B., Ph.D., U. of Chicago. Prof., Ecology and Systematics/History
Racker, Efraim, M.D., U. of Vienna (Austria). Albert Einstein Professor of Biochemistry; Biochemistry, Molecular and Cell Biology
Salpeter, Miriam M., Ph.D., Cornell U. Prof., Neurobiology and Behavior/Applied and Engineering Physics§
Schneiderman, Anne M., Ph.D., Harvard U. Asst. Prof., Neurobiology and Behavior
Seeley, Thomas D., Ph.D., Harvard U. Assoc. Prof., Neurobiology and Behavior
Sherman, Paul W., Ph.D., U. of Michigan. Assoc. Prof., Neurobiology and Behavior
Silver, Robert B., Ph.D., U. of California at Berkeley. Assoc. Prof., Physiology
Turgeon, Robert, Ph.D., Carleton U. (Canada). Assoc. Prof., Plant Biology
Wilson, David B., Ph.D., Stanford U. Prof., Biochemistry, Molecular and Cell Biology
Wolfner, Mariana F., Ph.D., Stanford U. Assoc. Prof., Genetics and Development

Other Teaching Personnel

Albrecht, Genia S., Ph.D., U. of Washington. Lecturer, Biochemistry, Molecular and Cell Biology
Calvo, Rita A., Ph.D., Cornell U. Sr. Lecturer, Genetics and Development
Eberhard, Carolyn, Ph.D., Boston U. Sr. Lecturer, Plant Biology

Joint Appointees

Likens, Gene E., Adjunct Prof., New York Botanical Garden Institute of Ecosystem Studies, Cary Arboretum/Ecology and Systematics
Regan, Elizabeth Adkins, Prof., Psychology/Neurobiology and Behavior

New York State College of Veterinary Medicine

Corradino, Robert A., Ph.D., Cornell U. Assoc. Prof., Physiology/Veterinary Physiology
Fortune, Joanne E., Ph.D., Cornell U. Assoc. Prof., Physiology/Veterinary Physiology
Gilmour, Robert F., Ph.D., SUNY Upstate Medical Center. Assoc. Prof., Physiology
Robertshaw, David, Ph.D., Glasgow U. (Scotland). Prof., Physiology
Tapper, Daniel N., Ph.D., Cornell U. Prof., Physiology/Veterinary Physiology
Wasserman, Robert H., Ph.D., Cornell U. Prof., Physiology/Veterinary Physiology/Nutritional Sciences*‡

Joint Appointees

Dobson Alan, Prof., Veterinary Physiology/Physiology
Houpt, Katherine A., Prof., Veterinary Physiology/Physiology
Houpt, T. Richard, Prof., Veterinary Physiology/Physiology
Kallfelz, Francis A., Prof., Clinical Sciences/Veterinary Physiology/Physiology
Nathanielsz, Peter W., Leading Prof., Clinical Sciences/Veterinary Physiology/Physiology
Wootton, John F., Prof., Veterinary Physiology/Physiology

College of Engineering

Joint Appointee

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

Division of Biological Sciences

Stinson, Harry T., Jr., Ph.D., Indiana U. Prof., Biological Sciences/Genetics and Development*

Division of Nutritional Sciences

Joint Appointees

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

*Joint appointment with the College of Arts and Sciences.
†Joint appointment with the College of Veterinary Medicine.
‡Joint appointment with the College of Agriculture and Life Sciences.
§Joint appointment with the College of Engineering.