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Biology

Subject abbreviation: BIOL
College of Natural and Agricultural Sciences

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Major

The Department of Evolution, Ecology, and Organismal Biology offers B.A. and B.S. degrees in Biology. Both programs are based on the conviction that broad undergraduate training in biology, mathematics, and the physical sciences, together with study in the humanities and social sciences, are fundamental to the education of a biologist. In addition to English composition, humanities,
social sciences and the Life Sciences core curriculum (see below, Major Requirements), both degrees require 36 units of upper-division (numbered 100-199) biology courses. The degrees differ in the humanities and social sciences requirements; also 16 units of a foreign language are required for the B.A., whereas the B.S. requires 16 additional units in substantive courses in biology or related fields.

The research and teaching of the Department of Evolution, Ecology, and Organismal Biology includes different levels (e.g., molecules, cells, organisms, populations, communities) and processes (e.g., development, evolution) of biological organization. An overview is presented in the introductory courses (BIOL 005A, BIOL 05LA, BIOL 005B, and BIOL 005C), and emphasis is placed on the unifying principles of the discipline.

Because of the diversity within biology and the wide range of career options, much latitude is allowed in selecting upper-division biology courses for the 36 units required for the major. Each student can select courses and plan a program of study to meet her/his specific interests and career goals. For assistance with this, academic advisors are available in the CNAS Academic Advising Center (1223 Pierce Hall, (951) 827-7254). The section below, Programs of Specialization, is provided as a guide for course selection for graduate schools, medical and health science professional schools and the broad range of careers that are possible with the Biology major.

The 36 upper-division units are selected from a list which includes courses offered by the Department of Evolution, Ecology, and Organismal Biology (BIOL 100-199) and a limited number of courses in Biochemistry (BCH), and Cell Biology and Neuroscience (CBNS). Qualified undergraduates (GPA 3.0 or above) may participate in graduate-level biology seminar courses with consent of the instructor, and up to 4 units (with letter grade) may be included in the major.

Those who choose to obtain a B.S. degree have as a college requirement an additional 16 units in upper-division biology courses and/or substantive courses in a field or fields related to the major. The purpose of this related area is to add strength and breadth to the major and to meet specific requirements for postgraduate study or a chosen career. The substantive courses in fields related to the major may be lower or upper division, but they usually have science or mathematics prerequisites (e.g., CBNS 120/PSYC 120, CHEM 005, STAT 100A, STAT 100B, MATH 009C).

The Thomas Haider Program at the UCR School of Medicine Students in the Biology major and all others at UCR are eligible to complete admission requirements and apply for up to 24 positions reserved for UCR students in the UCR School of Medicine. Students eligible to apply to this unique pathway into the UCR medical school, called the Thomas Haider Program at the UCR School of Medicine, are those who attend UCR for at least six consecutive quarters and complete their bachelor’s degree at UCR. Information on this program and general admission to the UCR medical school is provided at medschool.ucr.edu, in the school’s section of this catalog, in the medical school Student Affairs Office (1682A School of Medicine Education Building, (951) 827-4334), and at orientation meetings held at UCR.

University Requirements
See Undergraduate Studies section.

College Requirements
See College of Natural and Agricultural Sciences, Colleges and Programs section.

Major Requirements
Some of the following requirements for the major in Biology may also fulfill the College’s breadth requirements. Consult with an academic advisor for course planning.

1. Life Sciences core curriculum (68-72 units)
   a) BIOL 005A, BIOL 05LA or BIOL 020, BIOL 005B, BIOL 005C
   b) CHEM 001A, CHEM 001B, CHEM 001C, CHEM 011A, CHEM 011B, CHEM 011C
   c) CHEM 008A and 08LA or CHEM 08HA and CHEM 08LA, CHEM 008B and CHEM 08LB or CHEM 08HB and CHEM 08LB, CHEM 008C and CHEM 08LC or CHEM 08HC and CHEM 08LC
   d) MATH 007A or MATH 009A, MATH 007B or MATH 009B
   e) PHYS 002A, PHYS 002E, PHYS 002C, PHYS 020A, PHYS 020B, PHYS 020C
   f) STAT 100A
   g) BCH 100 or BCH 110A

   The core curriculum must be completed with a grade point average of 2.0 or better and no grade lower than "C-." If a grade of D or F is received in any of the core curriculum courses, either in separate courses or repetitions of the same course, the student will not be permitted to continue in the major.

2. Upper-division requirements (36 units)
   a) BIOL 102
   b) Thirty-two (32) additional Biology units to be taken in consultation with a faculty advisor

3. Other requirements
   For the Bachelor of Arts only (0-16 units): The foreign language requirement may be fulfilled by completing level four or the demonstration of equivalent proficiency in one foreign language.
   For the Bachelor of Science only (16 units): An additional 16 units in upper-division biology courses and/or substantive courses in a field or fields related to the major. A list of acceptable courses is available in the CNAS Academic Advising Center.

Programs of Specialization
The Life Sciences core curriculum (item 1 above) fulfills many of the requirements for admission to graduate schools in biology or professional schools in the medical and health science fields. In addition to Introductory Genetics (BIOL 102, 4 units), a wide choice is available for the remaining 32 upper-division units required for the Biology major (item 2.b) above and the 16 additional units related to the field of the major (B.S. degree, item 3 above). Each student selects upper-division and related courses depending on the type of school and career chosen (e.g., education, medicine, pharmacy, dentistry, optometry, veterinary medicine, nursing, physical therapy, public health, graduate school in one of the fields below).

In planning an academic program to prepare for teaching or one of the medical fields, present and prospective Biology majors are referred to relevant topics in the Biological Sciences section of this catalog. That section has information for those planning to attend graduate school in education to obtain a teaching credential (subsections, Teaching Credential) and/or a master's or Ph.D. degree in education (subsections, Preparation for Graduate School). Also included are guidelines to help students select courses for the admission to professional schools in the medical field (subsections, Medical Biology, Suggestions for Elective Units for Medical/Health Professions, Admission Requirements for Medical and Health Professional Schools). Additional information about required courses is available in the MCAT, OAT, PCAT, GRE can be obtained from (Velch Student Center) and the Health Professions Advising Center (visit 1114 Pierce Hall or hpsc.ucr.edu).

Suggested courses of study are provided below for those interested in various biological fields. These programs meet most of the requirements for admission to corresponding graduate schools for those students who wish to pursue a master's and/or Ph.D. degree. The faculty advisor assists in selecting combinations of courses appropriate for advanced study in the fields below and others. Students considering graduate study are encouraged to do undergraduate research and take courses in computer science and statistics.

In some cases, a course of study differing substantially from the examples given below will meet the needs of the student. In consultation with a faculty advisor, a student may prepare a program in some other biological specialization such as animal behavior, evolution/development or developmental biology.

Cell and Molecular Biology BIOL 102, BIOL 105, BIOL 107A, BIOL 107B, BIOL 109 or BIOL 153/BCH 153/PSYC 153, CBNS 101 or BIOL 113 and BIOL 114, BIOL 119, BIOL 121/MCBL 121, BIOL 121/MCBL 121, BIOL 122/MCBL 122, BIOL 123/MCBL 123/PLPA 123, BIOL 124/MCBL 124, BIOL 128/ CBNS 128, BIOL 155/PSYC 155, BIOL 156, BIOL 158, BIOL 160 or the BIOL 100A, BCH 110A, and BCH 110C sequence, BCH 102, CBNS 108, CBNS 150/ENXT 150, CHEM 005, CHEM 109, STAT 100A and STAT 100B.

Ecology and Population Biology BIOL 102, BIOL 104/PSYC 104, BIOL 105, BIOL 108, BIOL 116, BIOL 116, BIOL 117, BIOL 160, BIOL 160L, BIOL 174, either BIOL 175 or BIOL 143/PSYC 143, the MATH 007A or
MATH 009A, MATH 007B or MATH 009B, and MATH 009C sequence, STAT 100A and STAT 100B. Also recommended: BIOL 151, BIOL 161A, BIOL 163, BPSC 146, MATH 046, BIOL 165/165P, BIOL 166


Zoology and Physiology BIOL 100/ENTM 100, BIOL 102, BIOL 105, CBNS 101 or BIOL 113 and BIOL 114, BIOL 151, BIOL 152/ GEO 152, BIOL 157, BIOL 159, BIOL 160, BIOL 160L, BIOL 161A, BIOL 161B, BIOL 162/ENTM 162, BIOL 165, BIOL 171, BIOL 171L, BIOL 173/ENTM 173, BIOL 174, BIOL 175, BIOL 178, BCH 100, CBNS 106, CBNS 108, CBNS 116, CBNS 169. Students are also encouraged to take laboratory courses (e.g., BCH 102). Also recommended: a course in ecology (e.g., BIOL 116, BIOL 116L), STAT 100A and STAT 100B

California Teach-Science/Mathematics Initiative (CaTEACH-SMI) California Teach-Science/Mathematics Initiative (CaTEACH-SMI) has a goal of addressing the critical need of highly qualified K-12 science and mathematics teachers in California. With an economy increasingly reliant on science, technology, engineering, and mathematics (STEM) and the anticipated large scale retirement of qualified teachers, this is an essential time to explore and prepare for a career in teaching science or mathematics.

CaTEACH-SMI at UCR offers undergraduate students paid/unpaid opportunities, such as the SMI & Alpha Center Apprenticeship Programs, to explore STEM teaching as a career option. Through CaTEACH-SMI, students receive advising and mentoring to prepare for entrance into an intern teaching credential program while diligently coordinating with academic advisors to ensure completion of STEM degree requirements. The CaTEACH-SMI Resource Center provides future STEM teachers with material and financial resources which includes the National Science Foundation (NSF) Noyce Scholarship Program to promote planning and professional development towards a science/mathematics education career.

For more information about the CaTEACH-SMI program, please visit smi.ucr.edu, the Resource Center at 1315 Pierce Hall, or on Facebook at facebook.com/ScienceMathInitiativeUCr.

Additional Curricular and Advising Information
This catalog has sections applicable for all students at UCR (Finances and Registration, Academic Regulations), and a specific section for students in this college (College of Natural and Agricultural Sciences). Present and prospective students are referred to those sections for enrollment policies and procedures and curricular and advising information for the campus and college.

For Biology majors, information regarding the following topics can be obtained from the CNSA Undergraduate Academic Advising Center in 1223 Pierce Hall:
- Student Academic Advising
- Grading Basis: Letter Grade or S/N
- Full or Part-Time Study
- Transfer Students
- Minor
- Double Major
- Internships
- Preparation for Graduate School
- Education and Research Centers, Institutes, and Resources

Independent Study and Research
The Department of Evolution, Ecology, and Organismal Biology offers courses in which students can enroll to do independent laboratory research or an in-depth library study of a topic of special interest.

Students desiring to do Independent Reading (BIOL 194), Introduction to Research (BIOL 197) or Junior/Senior Research (BIOL 199) should contact a professor who is willing to supervise the project. The student may suggest a specific question or formulate a project after consultation with the instructor. Information about the research fields of the professors is available on the Department of Evolution, Ecology, and Organismal Biology website.

To enroll in these Independent Study and Research courses students should first contact the associated instructor for approval and proceed with enrolling through the CNSA Enrollment Management Center, preferably before the first day of instruction but no later than the end of the second week of the quarter.

Applicants for BIOL 194 and BIOL 199 should ordinarily be juniors or seniors with a GPA of 3.00 or higher. Sophomore students with a GPA of 3.00 or higher may apply to enroll in BIOL 197 (Introduction to Research), since the purpose of this course is to enable the student to do preliminary reading and laboratory research to explore with the professor the feasibility of undertaking a project for later enrollment in BIOL 199. Enrollment in BIOL 197 is not required before enrollment in BIOL 199, but the former course is available for those situations where preliminary work will be helpful.

For BIOL 194 and BIOL 199, the student writes a report of the library study or laboratory results for the quarter, which is reviewed by the sponsoring professor and submitted to the CNSA Academic Advising Center by the last day of instruction of the quarter.

BIOL 194, BIOL 197, and BIOL 199 are graded "S/N", and up to 9 units of credit may be counted as part of the 16 substantive units related to the major for the B.S. degree.

Natural Reserve System
This system was formed by the UC in 1965 to preserve for study a series of undisturbed natural areas representing the state's vast ecological diversity. Since then the system has grown to include thirty-seven reserves, eight of them administered by the UCR campus. See Research Opportunities in this catalog.

Most of the reserves are undeveloped except for fencing, roads and trails, but laboratory facilities, housing and campgrounds for class use are available at some sites. The reserves are used as outdoor classrooms and laboratories by students, teachers and researchers from educational institutions, public and private, throughout the state, across the nation and around the world. Some of the courses offered by the UCR Department of Evolution, Ecology, and Organismal Biology include field trips and overnight camping trips to the reserves. In the field, students are introduced to the great diversity of plant and animal organisms in Southern California, and to the effect of environmental factors on this diversity.

Undergraduate and graduate students who wish to use the reserves in their individual research projects should contact Dr. Kim Hammond, Department of Evolution, Ecology, and Organismal Biology, 3318 Spiehi Hall, (951) 827-4767, to obtain an application, map and list of rules and regulations.

Graduate Program
The Department of Evolution, Ecology, and Organismal Biology administers programs leading to the M.S. and Ph.D. degrees in Evolution, Ecology, and Organismal Biology, with specializations in Evolutionary Biology, Ecology, and Physiology and Biophysics.

Admission Applicants are strongly advised to contact potential faculty advisor prior to applying to the program. Applicants must submit GRE scores for the General Test (verbal, quantitative, and analytical). In addition, submission of the Subject Test score may improve chances of admission and is recommended.

All graduate students entering the department meet with a guidance committee during the first quarter of enrollment so that their educational background can be addressed. Considering the requirements of the student's specialization, the committee recommends a program of study to be followed in pursuit of graduate work. Because of the diversity among the specializations, course requirements for advanced degrees are specified by the student's guidance committee.

Doctoral Degree
The Department of Evolution, Ecology, and Organismal Biology offers the Ph.D. degree in Evolution, Ecology, and Organismal Biology. In addition to the general requirements of the Graduate Division, students intending to become candidates for the Ph.D. degree in Evolution, Ecology, and Organismal Biology must complete the following.
Course Work Course requirements are determined in consideration of the requirements of the student's area of specialization. Selection of specific courses is done by the guidance committee in consultation with the student.

All students are required to take EEOB 400, at least one of EEOB 210, EEOB 216 or EEOB 217 and at least one other four-unit graduate level course from an approved list. Students also are required to take two current research topics courses (Biol 252 or another disciplinary colloquium and EEOB 265) for a minimum of 5 quarters prior to advancement to candidacy and 12 quarters prior to completion of the doctoral degree.

Professional Development One unit of coursework in professional development, which is satisfied by EEOB 400.

Written and Oral Qualifying Examinations Students must pass a written examination in their specialized field of interest not later than the end of the second year of residence. Written Qualifying Examinations must be completed by the eighth week of the sixth quarter in residence. Upon successful completion of the Written Qualifying Examination, an Oral Qualifying Examination is administered wherein students defend a proposal detailing the rationale, specific aims, and approaches to be undertaken for their proposed dissertation research.

Dissertation Candidates may be required to successfully defend their dissertation research in a public oral presentation.

Teaching Requirement Students must have at least one year of approved teaching experience.

Normative Time to Degree 18 quarters

Master's Degree

The Department of Evolution, Ecology, and Organismal Biology offers the M.S. degree in Evolution, Ecology, and Organismal Biology, with specializations in Evolutionary Biology, Ecology, and Physiology & Biophysics. To qualify for the M.S. degree in Evolution, Ecology, and Organismal Biology, candidates must meet the requirements of the Department of Evolution, Ecology, and Organismal Biology.

These requirements are as follows:

Plan I (Thesis) Thirty-six (36) quarter units of approved courses in the 100 or 200 series, of which at least 24 units must be in the 200 series courses in the biological sciences. Not more than 12 units of EEOB 299 may be applied to the degree. A minimum of 12 units of course work other than courses in the 200 series must be completed in fulfillment of the requirement for 24 units of graduate courses. Students must present an acceptable thesis and undergo a final oral examination in defense of the thesis.

Lower-Division Courses

Biol 002 Cellular Basis of Life (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): none. An introduction to the fundamentals of life processes at the cellular level. Topics include cell structure, chemical composition, metabolism, reproduction, genetics, and development with emphasis on humans. Not recommended for natural science majors. Either BIOL 002 or BIOL 003 may be taken as a breadth requirement in biology; together they provide a general introduction to the field of biology. Credit is not awarded for BIOL 002 if it has already been awarded for BIOL 003A, BIOL 003A or BIOL 015.

BIOL 003 Organisms in Their Environment (4) lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): none. An introduction to the physiology, ecology, and evolution of living organisms with emphasis on humans. Not recommended for natural science majors. Either BIOL 002 or BIOL 003 may be taken as a breadth requirement in biology; together they provide a general introduction to the field of biology. Credit is not awarded for BIOL 003 if it has already been awarded for BIOL 005B.

BIOL 005A Introduction to Cell and Molecular Biology (4) lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 015A or BIOL 035A (may be taken concurrently) or BIOL 020 (may be taken concurrently) with grades of "C" or better; CHEM 001A and CHEM 001B with grades of "C" or better; or CHEM 010A and CHEM 011A with grades of "C" or better, consent of instructor is required for students repeating the course. An intensive course designed to prepare for upper-division courses in a cell biology, covers biochemistry, structural, metabolic, and genetic aspects of cells. Required for Biology majors; recommended for science majors desiring an introduction to biology.

BIOL 005B Introduction to Organismal Biology (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 005A and BIOL 015A or BIOL 020 with grades of "C" or better; CHEM 001A or CHEM 010A, CHEM 001B or CHEM 011B; consent of instructor is required for students repeating the course. An intensive course designed to prepare for upper-division courses in organismal biology. Covers developmental biology, physiology, and regulation at the level of the organism. Required for Biology majors; recommended for science majors desiring an introduction to biology.

BIOL 005C Introductory Evolution and Ecology (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 005A, BIOL 015A or BIOL 035A, and BIOL 005B with grades of "C" or better; MATH 008B with a grade of "C" or better or MATH 009A with a grade of "C" or better or equivalent; consent of instructor is required for students repeating the course. An intensive introduction to the subjects of evolution and ecology. Covers population and community ecology, community ecology, population genetics, and evolutionary theory. Recommended for science majors desiring an introduction to biology. Students who take equivalent first-year biology at another institution may enter directly into BIOL 005C without critical handicap.

BIOL 010 Headlines in the History of Life (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): none. Evolution of life beginning with precellular life. Topics include the origin of sex, multicellularity; vertebrate classes; morphological specializations, adaptive radiations; extinction dynamics; and the biology of dinosaurs. Cross-listed with GEO 003.

BIOL 020 Dynamic Genome (2) F Laboratory, 6 hours. Prerequisite(s): CHEM 001A or CHEM 011A, CHEM 008B or CHEM 009A (CHEM 009A may be taken concurrently); freshman standing. Introduces computational and experimental approaches in investigating the genomes of plants and animals. Explores scientific discovery using the tools of bioinformatics and genomics. Includes participation in research projects being conducted on campus. Credit is not awarded for BIOL 020 if it has already been awarded for BIOL 075A, Wessler.

BIOL 030 Human Reproduction and Sexual Behavior (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): none. A consideration of human anatomy, physiology, and behavior as related to sexual reproduction, including discussion of fertility, pregnancy, childbirth and birth control. Consideration will also be given to homosexuality, venereal diseases, sex education, sexual intercourse and response.

BIOL 034 Human Heredity and Evolution (4) Lecture, 3 hours; discussion and problem solving, 1 hour; audio-visual aids plus discussion, 1 hour. Basic human genetics and evolution, emphasizing their relationship to physical and emotional health. Political, philosophical and ethical implications of human heredity and evolution.

BIOL 040 Disease and History: From the Bubonic Plague to AIDS (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): none. This lecture course for nonscience majors will deal with the natural history of infectious diseases and how plagues have influenced the course of human history. It will cover the biology, pathology, epidemiology, and immunology of viruses, bacteria, and protozoan parasites causing smallpox, yellow fever, influenza, AIDS, syphilis, bubonic plague, tuberculosis, leprosy, malaria, and African sleeping sickness. The role of scientific inquiry in the conquest of human disease will be emphasized.

BIOL 055A Introduction to Cell and Molecular Biology Laboratory (1) Laboratory, 3 hours. Prerequisite(s): BIOL 005A (may be taken concurrently); consent of instructor is required for students repeating the course. An introduction to laboratory exercises on fundamental principles of and techniques in cell and molecular biology. Illustrates the experimental foundations of the topics covered in BIOL 005A. Credit is not awarded for BIOL 055A if it has already been awarded for BIOL 020.

Upper-Division Courses

BIOL 100 General Environments (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 005B, BIOL 005C, or equivalents; consent of instructor. Introductory study of insects: Earth's most diverse group of animals (75 percent of animal species are insects). Lecture covers the anatomy, physiology, ecology, behavior, and diversity of insects. Laboratory focuses on insect identification. Cross-listed with ENTM 100.

BIOL 102 Introductory Genetics (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005A, BIOL 020 or BIOL 055A, and BIOL 005B with grades of "C" or better. An introductory course that includes classical Mendelian genetics, linkage and recombination, sex-linked traits, cytogenetics, developmental genetics, and molecular genetics. Also includes some probability theory and statistics.

BIOL 104 Foundations of Plant Biology (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 005C. A study of the plant world from cells to ecosystems. Examines the structure and function of organisms from the major plant groups and their role in the biosphere. The laboratory explores the unique properties of plants. Cross-listed with BPS 104.

BIOL 105 Evolution (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005C with a grade of "C" or better; BIOL 030 or CHEM 010A, CHEM 011A, or CHEM 011B; CHEM 007B or MATH 009B or MATH 011B; PHYS 002C, PHYS 002C, BCH 100 or BCH 110A, one course in statistics; or consent of instructor. Covers the causal interrelation of organic diversity and adaptation. Topics include inference of evolutionary change from the fossil record and from genomic and molecular patterns; microevolution and macroevolution; systematics and the species problem; and natural selection, drift, and other forces of evolution.

BIOL 106 Biology of Human Variation (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 102; BIOL 105 or BIOL 108; STAT 100B may be taken concurrently; or consent of instructor. A survey of variation within and among contemporary human populations arising from genetic and environmental factors. Covers singl-locus and polygenic inheritance, developmental plasticity, and physio-
logical acclimatization. Includes biogeographic and demographic influences; variation in pigmentation, stature, physiology, disease susceptibility, behavior, and IQ; and critical evaluation of racial and ethnic classifications.

BIOL 107A Molecular Biology (4) Lecture; 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005A, BIOL 005B, BIOL 005C, CHEM 001G or CHEM 01HC, CHEM 008C and CHEM 08BC, or CHEM 08BC and CHEM 08HL, MATH 007B or MATH 009B or MATH 091B, PHYS 002C, PHYS 02LC, BCH 100 or BCH 110A. A course in statistics. Examination of the organization and function of eukaryotic cells. Topics include membrane systems, protein targeting, the cytoskeleton, motility, and cell division. Emphasis is on the experiments that form the basis of the current understanding of the cell. The discussion section focuses on reading and analyzing original journal articles.

BIOL 114 Advanced Cell Biology: Cellular Reproduction and Signaling (4) Lecture; 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005B, BIOL 005C, CHEM 001G or CHEM 01HC, CHEM 008C and CHEM 08BC, or CHEM 08BC and CHEM 08HL, MATH 007B or MATH 009B or MATH 091B, PHYS 002C, PHYS 02LC, BCH 100 or BCH 110A. A study of the structure and function of the genetic material, including DNA structure, DNA replication and expression, regulation of gene expression, and protein synthesis. Examines both prokaryotic and eukaryotic systems including contemporary recombinant DNA technology and applications of molecular cloning procedures. Credit is not awarded for both BIOL 107A if it has already been awarded for BCH 110C.

BIOL 107B Advanced Molecular Biology (3) Lecture; 2 hours; discussion, 1 hour. Prerequisite(s): BIOL 107A or BCH 110C or equivalents. An advanced treatment of the functional architecture of genetic material. Topics include genome structure and chromosome organization, DNA replication and gene expression, cloning organisms, modification, protein engineering, and application of modern molecular biology to agricultural problems. Coverage of each topic includes discussion of the impact of the emergent molecular technology on society.

BIOL 108 Population Genetics and Genomics (4) Lecture; 3 hours; discussion and demonstration, 1 hour per week. Prerequisite(s): BIOL 005A, BIOL 005B, BIOL 005C, CHEM 001G or CHEM 01HC, CHEM 008B or CHEM 08BC, or CHEM 08BC and CHEM 08HL, MATH 007B or MATH 009B or MATH 091B, PHYS 002C, PHYS 02LC, one course in statistics. A study of factors influencing genotypic variation in biological populations. Topics include the effects of natural selection and genetic drift on genetic variation, detecting adaptive change from genomic data, why genetic diseases and cancers persist, the evolution of cooperation, adaptation to pathogens and to a changing environment, and the genetic challenges faced by small conserved populations.

BIOL 110 Biology of Human Problems (4) Seminar, 4 hours. Prerequisite(s): BIOL 005A, BIOL 005B, BIOL 005C, CHEM 001G or CHEM 01HC, CHEM 008B or CHEM 08BC, or CHEM 08BC and CHEM 08HL, MATH 007B or MATH 009B or MATH 091B, PHYS 002C, PHYS 02LC, BCH 100 or BCH 110A. One course in statistics. Devoted to selected human problems that have a large biological component and relate to nutrition, ethics, and human existence. Topics covered vary and include issues of major biocultural importance such as euthanasia, national health care, effects of industrial pollution on individuals and communities, population problems, abortion, and genetic engineering.

BIOL 111 Infectious Disease (1) Lecture; 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005A, BIOL 005B, and BIOL 005C with a grade of "C" or better, BIOL 102 with a grade of "C" or better, STAT 100A or equivalent (or consent of instructor) with a grade of "C" or better. Introduces infectious diseases. Includes examples and case studies presented for a variety of human infectious diseases. Required.

BIOL 112 Systematics (4) Lecture; 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005C or equivalent. Principles and philosophy of classification: phylogenetic and phenetic concepts, taxonomic characters, evolution, hierarchy of categories, and nomenclature. Cross-listed with BPSC 112 and ENTM 112.

BIOL 113 Advanced Cell Biology: Membranes, Organelles, and the Cytoskeleton (4) Lecture; 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005A, BIOL 005B, BIOL 005C, BIOL 102, CHEM 001G or CHEM 008C and CHEM 08BC, CHEM 08BC and CHEM 08HL, MATH 007B or MATH 009B or MATH 091B, PHYS 002C, PHYS 02LC, BCH 100 or BCH 110A, one course in statistics. An introduction to the science of genomics and bioinformatics. Includes genome sequencing; database techniques; structural, comparative, and evolutionary genomics; and microarray analysis.

BIOL 120 Introduction to Plant Pathology (3) Lecture. 3 hours. Prerequisite(s): BIOL 005A, BIOL 005B, or BIOL 005C, or BIOL 005A, or BIOL 005B, or BIOL 005C, or CHEM 001G or CHEM 01HC, CHEM 008C and CHEM 08BC, or CHEM 08BC and CHEM 08HL, MATH 007B or MATH 009B or MATH 091B, PHYS 002C, PHYS 02LC, BCH 100 or BCH 110A, one course in statistics; or consent of instructor. An introduction to the study of plant diseases and the causes of plant diseases. Topics include disease concepts; disease-causing agents, host-pathogen interaction during disease development, and strategies for disease management. An optional, separate laboratory is offered. Cross-listed with PLPA 210. Credit is not awarded for both BIOL 120/MCB/120/PLPA 120 and/or BIOL 120/MCB/120/PLPA 120 and/or BIOL 120/MCB/120/PLPA 120.

BIOL 120 Introduction to Plant Pathology (4) Lecture; 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005A, BIOL 005B, or BIOL 005C, or CHEM 001G or CHEM 01HC, CHEM 008C and CHEM 08BC, or CHEM 08BC and CHEM 08HL, MATH 007B or MATH 009B or MATH 091B, PHYS 002C, PHYS 02LC, BCH 100 or BCH 110A, one course in statistics; or consent of instructor. A course in the identification, isolation, and identification of plant pathogens that cause disease in plants. Cross-listed with MCB/120 and PLPA 120. Credit is not awarded for PLPA 210 if it has already been awarded for BIOL 120/MCB/120/PLPA 120 and/or BIOL 120/MCB/120/PLPA 120.

BIOL 121 Introductory Microbiology (4) Lecture; 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 005A, BIOL 005B, or BIOL 005C, or CHEM 001G or CHEM 01HC, CHEM 008C and CHEM 08BC, or CHEM 08BC and CHEM 08HL, MATH 007B or MATH 009B or MATH 091B, PHYS 002C, PHYS 02LC, BCH 100 or BCH 110A, one course in statistics; or consent of instructor. Course title includes a variety of infectious agents affecting humans. Cross-listed with MCB/121.

BIOL 121 Introduction to Microbiology (4) Lecture; 3 hours; laboratory; 6 hours. Prerequisite(s): BIOL 121/ MCB/121 with a grade of "C" or better. A laboratory course in diagnostic instrum
Biology 171 Human Anatomy and Physiology (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 161A, CHEM 008C, CHEM 008L, or CHEM 008C and CHEM 008L, MATH 009B or MATH 009B or MATH 098B, PHYS 002C, PHYS 02LC, BCH 100 or BCH 110A; one course in statistics; concurrent enrollment in BIOL 171 is recommended. Analysis of cell, tissue, and organ structure and function in normal and diseased conditions. Topics include the muscular-skeletal, circulatory, and autonomic nervous systems; glands and hormones; body fluids and the kidney; digestive, respiratory, endocrine, and both normal and abnormal aspects of growth and development. Experiments emphasize principles of physics and engineering in the study of the relationship between organismal form and function. Covers examples from diverse plant and animal systems. Includes fundamental properties of solids and fluids, transport mechanisms, drug, biological pumps, locomotion, and muscle mechanics.

Biology 171 Human Anatomy and Physiology Laboratory (1) Laboratory, 3 hours. Prerequisite(s): BIOL 161A (may be taken concurrently), CHEM 008C, CHEM 008L, CHEM 008C and CHEM 008L, MATH 009B, MATH 098B, PHYS 002C, PHYS 02LC, BCH 100 or BCH 110A, one course in statistics; concurrent enrollment in BIOL 171 is recommended. An analysis of cell, tissue, and organ structure and function in normal and diseased conditions. Topics include the muscular-skeletal, circulatory, and autonomic nervous systems; glands and hormones; body fluids and the kidney; digestive, respiratory, endocrine, and both normal and abnormal aspects of growth and development. Experiments emphasize principles of physics and engineering in the study of the relationship between organismal form and function. Covers examples from diverse plant and animal systems. Includes fundamental properties of solids and fluids, transport mechanisms, drug, biological pumps, locomotion, and muscle mechanics.

Biology 171 Special Studies (1-4) Individual study, 3-12 hours. Prerequisite(s): consent of instructor and departmental chairperson. To be taken as a means of meeting special curricular needs. Grading basis to be selected in consultation with the instructor and departmental chairperson. Course is repeatable.

Biology 171 Seminar in Biology (2-4) Seminar, 2-4 hours. Prerequisite(s): upper-division standing; consent of instructor. A critical study of selected topics in biology. Course is repeatable.

Biology 173 Insect Physiology (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): BIOL 008A, BIOL 008B, BIOL 008C, CHEM 001C or CHEM 001H, CHEM 008B and CHEM 008L, or CHEM 008C and CHEM 008L, MATH 009B or MATH 098B, PHYS 002C, PHYS 02LC, BCH 100 or BCH 110A, one course in statistics; concurrent enrollment in BIOL 173 is recommended. A one-year sequence in vertebrate and human anatomy and physiology.

Biology 174 Ecological and Evolutionary Physiology (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 008A, BIOL 008B, BIOL 008C, CHEM 001C or CHEM 001H, CHEM 008B and CHEM 008L, or CHEM 008C and CHEM 008L, MATH 009B or MATH 098B, PHYS 002C, PHYS 02LC, BCH 100 or BCH 110A, one course in statistics; concurrent enrollment in BIOL 174 is recommended. A one-year sequence in vertebrate and human anatomy and physiology. Studies include growth, development and hormones, cuticle, nervous system, circulation, respiration, digestion, nutrition, excretion, reproduction, water balance, and temperature relations. Prior knowledge of insects is not assumed. Cross-listed with ENT 173.

Biology 175 Comparative Animal Physiology (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 008A, BIOL 008B, BIOL 008C, CHEM 001C or CHEM 001H, CHEM 008B and CHEM 008L, or CHEM 008C and CHEM 008L, MATH 009B or MATH 098B, PHYS 002C, PHYS 02LC, BCH 100 or BCH 110A, one course in statistics. Examines the interactions between organisms and their environment, emphasizing coadaptation of physiological, morphological, and behavioral phenotypes. Includes allozyme and scaling, metabolism and locomotion, heat and water stress, regulation of endothermy, artificial selection experiments, and phylogenetically based statistical methods.

Biology 176 Comparative Biomechanics (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BIOL 008C, PHYS 002C or PHYS 040C, BCH 100 or BCH 110A. Topics include principles from physics and engineering to understand the relationship between organismal form and function. Covers examples from diverse plant and animal systems. Includes fundamental properties of solids and fluids, transport mechanisms, drug, biological pumps, locomotion, and muscle mechanics.

Graduate Courses

Biology 200 Cell Biology (4) Lecture, 3 hours; seminar, 1 hour. Prerequisite(s): BCH 110A or BCH 110B or equivalent (may be taken concurrently); BIOL 102 or equivalent; BCH 113 or BCH 114 or CLNS 101 or equivalent. An examination of the structure and function of eukaryotic cells and their components with emphasis on the key experiments that provide the foundation for our current understanding. Covers topics such as cell membranes, intracellular trafficking, cell-to-cell interactions, motility, and the cytoskeleton. Cross-listed with CMBD 200.

Biology 201 Molecular Biology (4) Lecture, 3 hours; seminar, 1 hour. Prerequisite(s): BCH 110A or BCH 110B or equivalent (may be taken concurrently); BIOL 102 or equivalent; BCH 107A or equivalent. Covers the structure and inheritance of genetic material, the regulation of gene expression at the cellular and molecular level including molecular mechanisms for regulation of gene transcription, posttranscriptional regulation at the level of message RNA stability, processing, splicing and translation, methods for gene mapping, and positional cloning. Cross-listed with CMBD 201.

Biology 203 Cellular Biophysics (3) Lecture, 3 hours. Prerequisite(s): BIOL 200; CMBD 200, BIOL 201; CMBD 201, CHEM 109 or equivalent; consent of instructor. Biophysical principles that determine cellular structure and function including diffusion, electrochemical gradients, transport, macromolecular interactions, and genetic regulation. Illustrative examples are used to highlight the importance of these principles in modern cell biology and physiology.

Biology 211 Microbial Genetics (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): BCH 110C or BIOL 107A; BIOL 102, in-depth coverage of the genetics of microbes. Examines the primary data and the foundation of modern techniques using viruses, bacteria, and prokaryotes. Includes genome sequences and organization, plasmids and other vectors, and mutation and genetic screens. Also covers transposable elements, recombination, and regulation of gene expression, development, and pathogenesis. Cross-listed with MUSC 221 and PLPA 226, Berkovitch.

Biology 250 Special Topics in Biology (1-2) Seminar, 1-2 hours. Prerequisite(s): graduate standing and consent of instructor. Lecturers present intensive small-group discussion of selected topics in the area of special competence of each staff member. Course content will emphasize recent advances in the special topic area and will vary accordingly. Graded Satisfactory (S) or No Credit (NC). May be repeated for credit.

Biology 252 General Colloquium in Biology (1) Seminar, 1 hour. Discussion, 1 hour. Prerequisite(s): graduate standing. Oral reports based on current biological research. Graded Satisfactory (S) or No Credit (NC). May be repeated for credit.

Biology 261 Seminar in Genetics, Genomics, and Bioinformatics (1) Seminar, 1 hour. Prerequisite(s): graduate standing or consent of instructor. Oral reports by visiting scholars, faculty, and students on current research topics in Genetics, Genomics, and Bioinformatics. Graded Satisfactory (S) or No Credit (NC). Course is repeatable. Cross-listed with BCH 261, BPSC 261, ENT 261, GEN 261, and PLPA 261.

Biology 281 (E-2) Seminar in Cell Development, Structure, and Function (2) Seminar, 2 hours. Prerequisite(s): graduate standing. Lectures, discussions, and demonstrations by students, faculty, and invited scholars on selected topics concerned with the principles of cell development, structure, and function. E. Cell Biology; F. Molecular Biology; Q. Developmental Biology. Segments are repeatable. Cross-listed with CMBD 281 (E-2).

Biology 284 Seminar in Biology (2-4) Seminar, 2-4 hours. Prerequisite(s): graduate standing; consent of instructor. An interdisciplinary seminar consisting of student presentations and discussion of selected topics in neuroscience. Students register in fall semester only, and each time course is offered. Students who present a seminar receive a letter grade; other students receive a Satisfactory (S) or No Credit (NC) grade. Course is repeatable. Cross-listed with BCH 289, BCH 289, ENTR 289, NRSC 289, and PSY 289.

EECE 210 Organismic Biology (4) Lecture, 4 hours. Prerequisite(s): At least one upper division undergraduate course that covers the principles of physiology (such as animal physiology, plant physiology, human physiology, or comparative anatomy and physiology), or a similar course; AND an upper division undergraduate course that covers the principles of evolution, or a similar course. OR consent of instructor. Explores the historical development of modern ideas in organismal biology. Topics include homeostasis, scaling, energetics, structure-function relationships, control
systems, and response systems. Examines recent research in the context of the classic studies.

EEOB 211 Foundations of Ecology (4) Lecture, 4 hours. Prerequisite(s): BIOL 116 or consent of instructor. Examination of the history, theory, and interrelationships of fundamental ecological principles through readings and discussions of classic and recent literature. Topics include quantitative, population, community, ecosystem, evolutionary, and conservation ecology.

EEOB 212 Ecological Systems in Space and Time (4) Lecture, 3 hours; field, 30 hours per quarter. Prerequisite(s): One upper-division undergraduate course in population or community ecology or paleoecology, or consent of instructor. Focuses on how ecological systems are interpreted and reconciled at the community, landscape, and paleoecological scales. Addresses the role of extrinsic factors operating at each of these scales. Also considers development of our understanding of ecological systems at various scales. Cross-listed with ENTM 212 and GEO 212.

EEOB 213 Behavioral Ecology (4) Lecture, 4 hours. Prerequisite(s): BIOL 160 or consent of instructor. Examines animal behavior in an evolutionary context. Traces the historical development of the study of behavior, drawing from ethology, comparative psychology, and sociobiology. Topics include evolutionarily, socially, sexual selection, predator-prey behavior, and parental care.

EEOB 214 Evolutionary Genetics (4) Lecture, 4 hours. Prerequisite(s): BIOL 108 or consent of instructor. Traces the historical development of modern ideas in evolutionary genetics. Focuses on the influence of Fisher, Haldane, and Wright on current views of genetic variation in natural populations, by examining recent research in the context of their classic works.

EEOB 215 Advanced Methods of Data Analysis in Evolution, Ecology, and Behavior (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): PSYC 212 or STAT 100S or equivalent. Introduces students to new methods of data analysis in the fields of evolution, ecology, and behavior. Covers theory and practical application using relevant examples. Topics include maximum likelihood, randomization, the jackknife, bootstrapping, Monte Carlo approaches, and meta-analysis.

EEOB 216 The Theory of Evolution (4) Lecture, 4 hours. Prerequisite(s): BIOL 105 or consent of instructor. Traces the historical development of modern ideas in evolutionary theory. Focuses on the influence of Darwin and the various authors of the modern synthesis on current views of macroevolution by examining recent research in the context of their classic works.

EEOB 217 Advanced Population and Community Ecology (4) Lecture, 4 hours. Prerequisite(s): One upper-division undergraduate course in population or community ecology, or consent of instructor. Traces the development of the major concepts in ecology. Focuses on the influence of pioneers in the field, historical roots of key concepts, and key controversies. Evaluates current research with reference to these historical origins. Redak

EEOB 219 Theory of Systematics (4) Lecture, 4 hours. Prerequisite(s): BIOL 112/PSYC 112/ENTM 112 or equivalent or consent of instructor. Examines topics developped around a series of classical and recent papers on the principles, philosophy, and methodology of modern systematics and phylogenetic methods. Cross-listed with ENTM 219 and GEO 219.

EEOB 220 Evolutionary Physiology (4) 5, Even Years Lecture, 4 hours. Prerequisite(s): One upper-division course in evolution and animal physiology or behavior, or consent of instructor. Covers evolutionary approaches to the study of animal physiology, includes organismal and organ-system physiology, biometrics and locomotor mechanisms; cell physiology; the development of physiological systems; and behavioral neuroscience. Althuler, Garland, Jr.

EEOB 230 Analysis of Ecological Communities (5) Lecture, 3 hours; discussion, 2 hours. Prerequisite(s): PSYC 212 or STAT 231B or equivalent; consent of instructor. Covers principles of multivariate analysis and its application to the interpretation of ecological community data. Topics include multiple and partial correlation and regression, canonical correlation, detrended and canonical correspondence analysis, multidimensional scaling, similarity indices and cluster analysis, and discriminant analysis.

EEOB 265 Advances in Population and Evolutionary Biology (1 or 2) Seminar, 1 hour, outside research, 0.3 hours. Prerequisite(s): graduate standing or consent of instructor. Presentations by visiting scholars, faculty, and students on current research topics in population and evolutionary biology. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

EEOB 282 Seminar in Genetics and Evolution (2-4) Seminar, 2-4 hours. Prerequisite(s): graduate standing, consent of instructor. Presentations by students, faculty, and invited scholars on selected topics concerned with the principles of genetics and evolution. Course is repeatable.

EEOB 283 Seminar in Organismal Biology (1-4) Seminar, 1-4 hours. Prerequisite(s): graduate standing, consent of instructor. Presentations by students, faculty, and invited scholars on selected topics concerned with the principles of organismal biology, including physiology, behavior, morphology, biomechanics, and related topics. Course is repeatable to a maximum of 18 units.

EEOB 280 Directed Studies (1-6) Individual study, 3-18 hours. Prerequisite(s): graduate standing, consent of instructor and associate professor. Individual studies on specially selected topics in evolution, ecology, and organismal biology under the direction of a faculty member. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

EEOB 281 Individual Study in Coordinated Areas (1-6) Individual study, 3-18 hours. Prerequisite(s): graduate standing. Provides a program of study designed to assist and advise candidates who are preparing for examinations. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

EEOB 282 Concurrent Analytical Studies in Evolution, Ecology, and Organismal Biology (2-4) Outside research, 6-12 hours. Prerequisite(s): consent of instructor. Elected concurrently with an appropriate undergraduate course, but on an individual basis. Designed to one or more graduate papers based on research or criticism related to the course. Faculty guidance and evaluation provided throughout the quarter. Course is repeatable.

EEOB 289 Research for the Thesis or Dissertation (1-12) Outside research, 3-36 hours. Prerequisite(s): graduate standing. Original research in an area selected for the advanced degree. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

Professional Courses

BIOL 301 Teaching of Biology at the College Level (1) Seminar, 1 hour, Prerequisite(s): graduate standing. A program of weekly meetings and individual formative evaluations required for new Biology Teaching Assistants. Covers instructional methods and classroom section activities most suitable for teaching Biology.