

Oral Qualifying Examination Following successful completion of the written examination, candidates for the doctoral degree must pass an oral examination, normally within three quarters of the date of their written exam. The oral examination is scheduled only after the candidate has written a proposal detailing the rationale, specific aims and approaches to be undertaken for her/his dissertation research.

Dissertation A written dissertation is completed by each student.

Candidates for the degree of Ph.D. may be required to defend the dissertation in a public, oral presentation at a time announced to members of the University community.

Core Courses All Bioengineering graduate students are required to take at least three courses from the following six Bioengineering courses. Other courses may be substituted but must be approved by the bioengineering graduate advisor. Students from non-engineering backgrounds are also required to take BIEN 268 in addition to the courses stipulated here.

Bioengineering Core

1. BIEN 220 - Chemical Genomics Design Studio
2. BIEN 223 - Engineering Analysis of Physiological Systems
3. BIEN 224 - Cellular and Molecular Engineering
4. BIEN 249 - Integration of Computational and Experimental Biology
5. BIEN 264 - Dynamics of Biological Systems
6. BIEN 268 - Bioengineering Experimentation and Analysis

Other required courses:

1. One bioscience class chosen from: BCH 210, BCH 211, BCH 212, BIOL/CMDB 200, BIOL/CMDB 201, BIOL 203, BIOL 221/MCBL 221/PLPA 226, or, with consent of instructor, BMSC 229, BMSC 230, BMSC 231, BMSC 232, BMSC 234, and BMSC 235.
2. Other courses may be substituted but must be approved by the Bioengineering Graduate Advisor.
3. BIEN 286 - Colloquium in Bioengineering
This course is required every quarter in which it is offered.

Additional courses may be required by the Advisory Committee depending on the student's background and fields of interest.

M.S. and Ph.D. students must complete the course requirements for the programs within their first year of residence.

Course Descriptions All Bioengineering courses are listed and described under Bioengineering.

Biological Sciences

Subject abbreviation: BLSC
College of Natural and Agricultural Sciences

_____, Director
Raphael Zidovetzki, Lead Advisor
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(951) 827-3579

Committee in Charge

Edith Allen, Ph.D. *Conservation Biology, Evolution and Ecology, Plant Biology*
Katherine Borkovich, Ph.D. *Microbiology*
Xuemei Chen, Ph.D. *Bioinformatics and Genomics*
David A. Johnson, Ph.D. *Medical Biology*
Howard Judelson, Ph.D. *Cell, Molecular, and Developmental Biology*
Morris Maduro, Ph.D. *Biology*
Frances Sladek, Ph.D. *Environmental Toxicology*
Linda L. Walling, Ph.D.
Divisional Dean Life Sciences, College of Natural and Agricultural Sciences, ex officio

Faculty, see listings for

Department of Biology
Department of Botany and Plant Sciences
Department of Cell Biology and Neuroscience
Department of Entomology
Department of Environmental Sciences
Department of Nematology
Department of Plant Pathology and Microbiology

Major

Biological Sciences is an interdepartmental major that includes faculty (more than 150) from seven departments in the College of Natural and Agricultural Sciences. The major offers the B.S. degree and is unified by the Life Sciences core curriculum (see below, Major Requirements), which students complete during their initial years at UCR or at another college or university (transfer students).

For advanced study in the junior and senior years, students select an area of specialization (track) from the nine that are now available: Bioinformatics and Genomics; Biology; Cell, Molecular and Developmental Biology; Conservation Biology; Evolution and Ecology; Environmental Toxicology; Medical Biology; Microbiology; and Plant Biology. Each track provides the opportunity to combine broad basic training in biological sciences with an emphasis in an area of particular interest to the student. Both the name of the major (Biological Sciences) and the track are included on the official transcript.

The organization of the major into tracks and the participation of a large number of faculty allows a diversity of student choices that could not be provided by a single department. The track structure allows flexibility to incorporate new faculty and research areas so students can prepare for graduate study and careers in emerging fields of biology. As their interests change and develop during the initial years at UCR, students can easily change their track selection for the junior and senior years.

As can be seen from the track descriptions and other items below, the Biological Sciences major provides preparation for a broad diversity of professional schools, graduate schools and careers. Students in this major and all others at UCR are eligible to complete admission requirements and apply to medical schools throughout the United States, including the 24 positions reserved for UCR students in the joint UCR/UCLA medical school (Thomas Haider Program in Biomedical Sciences). For additional information, see below, Admission Requirements for Medical and Health Professional Schools.

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 may also fulfill the college's breadth requirements. Consult with a department advisor for program planning.

The major requirements for the B.S. in Biological Sciences are as follows:

1. Life Sciences core requirements (68-72 units)
Students must complete all required courses with a grade of "C-" or better and with a cumulative GPA in the core courses of at least 2.0. Grades of "D" or "F" in two core courses, either separate courses or repetitions of the same course, are grounds for discontinuation from the major.
 - a) BIOL 005A, BIOL 05LA, BIOL 005B, BIOL 005C
 - b) CHEM 001A, CHEM 001B, CHEM 001C, CHEM 01LA, CHEM 01LB, CHEM 01LC, CHEM 112A, CHEM 112B, CHEM 112C
 - c) MATH 008B or MATH 009A, MATH 009B
 - d) PHYS 002A, PHYS 002B, PHYS 002C, PHYS 02LA, PHYS 02LB, PHYS 02LC
 - e) STAT 100A
 - f) BCH 100 or BCH 110A
2. As specified in the individual tracks, at least 36 upper-division units for the major and 16 units of substantive course work related to the major. Courses in Statistics and Biochemistry taken as part of the core may be included.

A student is subject to discontinuation from the major whenever the GPA in upper-division course work is below 2.0. Students finding themselves in this circumstance must meet with an advisor.

Bioinformatics and Genomics Track

Bioinformatics and Genomics are popular new fields whose emergence is catalyzed by the explosion of data made available through automated DNA sequencing. They meld in a seamless fashion genetics, molecular and

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cellular biology, statistics, and computer science. This curricular track has been carefully designed to be flexible so that avenues of study can be computational or experimental, or both, and therefore has wide appeal to students of varying interests. This track is unique in its ability to accommodate agricultural, microbial, and animal bioinformatics and genomics under a single programmatic umbrella and allow students to interface with instructors from a broad array of departments. The interdisciplinary nature of Bioinformatics and Genomics prepares students to be highly competitive for further graduate education or for immediate placement in biotechnology and allied industries.

1. Computer Science and Mathematics (16 units). These courses satisfy the related areas requirement.
 - a) CS 010, CS 012, CS 014
 - b) MATH 009C
2. Ethics and Science (4 units): At least one course from PHIL 117, PHIL 118, PHIL 161, RLST 170. This course may also satisfy a portion of the college's breadth requirements in Humanities.
3. Upper-division requirements (a minimum of 45 units)
 - a) BCH 110A (recommended) or BCH 100
 - b) BIOL 102, BIOL 105, BIOL 107A or BCH 110C, BIOL 119
 - c) STAT 100A, STAT 100B, STAT 160A, STAT 160B
 - d) Breadth electives (at least one course from each area)
 - (1) Bioinformatics and Computational Biology (CS 141 and MATH 112 recommended): CS 141, CS 166, CS 170, CS 171, MATH 112, MATH 120, MATH 135A, STAT 160C, STAT 161, STAT 170A, STAT 170B
 - (2) Genomics, Macromolecules, and Molecular Biology: BIOL 107B, BIOL 108, BIOL 109 or BCH 153/BIOL 153/BPSC 153 or BCH 162, BPSC 148/BIOL 148, CBNS 150/ENTX 150

Note Independent study or research in the field of bioinformatics or genomics is recommended.

Biology Track

The Biology track provides up-to-date preparation for postgraduate study and careers in the fields of medicine, health science, teaching, and research. These options require understanding and integration of the different levels and processes of biological organization. The levels include cell and molecular, organismal, community and population; important life processes are reproduction, development, and evolution. An overview is presented in the introductory courses (BIOL 005A, BIOL 05LA, BIOL 005B, BIOL 005C), and emphasis is placed on the unifying principles of the discipline.

The upper-division courses are more specialized and provide in-depth examination of specific subfields of biology. From a list of courses in each area, students select three upper-division courses in cell or molecular biology, two courses in the structure and function of organisms, and two courses in a subfield with the following integrated and overlapping topics: ecology, evolution, systematics, and behavior. Hands-on learning is encouraged so that students can participate rather than just observe science in this age of technology. Among the upper-division biology courses, there must be at least two courses that have a laboratory or field component.

Students in this track also select two courses from a number of options in computer science and statistics. Statistics is needed to plan and carry out experiments, read and understand scientific literature, and interpret data in medicine and other fields of science. Computers facilitate communication and data processing and storage, and computer technology is now an integral part of modern life.

1. Upper-division requirements [at least 36 units from the following, including two courses with laboratory or field component (indicated by *)]

Note Courses listed in more than one category may be used to satisfy only one requirement.

- a) Cell/Molecular (minimum of one course from each category)
 - (1) BCH 100 or both BCH 110A and BCH 110B
 - (2) BIOL 102 or BIOL 115
 - (3) BIOL 107A or BCH 110C, CBNS 101 or BIOL 113 or BIOL 114, BIOL 119, BIOL 128/CBNS 128, BPSC 155/BIOL 155
- b) Functional Biology of Organisms (minimum of two courses with lecture component)
 - BIOL 100/ENTM 100*,
 - BIOL 104/BPSC 104*,
 - BIOL 121/MCBL 121,
 - BIOL 121L/MCBL 121L*, BIOL 124/MCBL 124, BIOL 132/BPSC 132*,
 - BIOL 134/PLPA 134,
 - BIOL 134L/PLPA 134L*,
 - BIOL 138/BPSC 138*,
 - BIOL 143/BPSC 143*, BIOL 151*,
 - BIOL 157*, BIOL 159/NEM 159,
 - BIOL 161A*, BIOL 161B*,
 - BIOL 173/ENTM 173*, BIOL 174,
 - BIOL 175, BIOL 178, CBNS 106,
 - CBNS 169
- c) Ecology/Evolution/Systematics/Behavior (minimum of two courses with lecture component)
 - BIOL 105, BIOL 108, BIOL 112/
 - BPSC 112/ENTM 112, BIOL 116,
 - BIOL 116L*, BIOL 117 or BIOL 127/
 - ENTM 127, BIOL 119, BIOL 152/

GEO 152*, BIOL 160, BIOL 160L*,
BIOL 162/ENTM 162, BIOL 163*,
BIOL 174

d) Additional Elective Courses

BIOL 107B, BIOL 109* or BCH 153/
BIOL 153/BPSC 153*, BIOL 110,
BIOL 120/MCBL 120/
PLPA 120, BIOL 120L/MCBL 120L/
PLPA 120L*, BIOL 122/MCBL 122,
BIOL 123/MCBL 123/PLPA 123,
BIOL 148/BPSC 148, BIOL 158, BIOL
165/BPSC 165*, BIOL 166*, BIOL 168,
BIOL 171, BIOL 171L*, BIOL 185 (E-Z),
BIOL 191, CBNS 150/ENTX 150

2. Statistics/Computer Science requirement (two courses)

CS 010, CS 011/MATH 011, CS 012,
CS 014, CS 021, CS 061, CS 120A/
EE 120A, CS 143/EE 143, STAT 100A,
STAT 100B

3. Additional courses in biological sciences (upper division) and related areas from the approved list to bring total units to 52. Eight of these units may be from a declared minor in one of the science colleges, or additional lower-division science requirements for the teaching credential (advisor's approval required).

Cell, Molecular, and Developmental Biology Track

Cell, Molecular, and Developmental Biology are important subdisciplines in the Biological Sciences. Students take a series of gateway courses and at least one upper-division laboratory course which acquaints them with the basic techniques used in this field, introduces them to experimental design in the laboratory, and teaches them how to interpret laboratory data. Students build depth in Cell, Molecular, and Developmental Biology by taking additional upper-division lecture courses from a diverse menu that may be tailored to suit each student's interests. Students add breadth to their science training by completing courses from the list of "additional courses." Students interested in the medical or health science field should choose appropriate medically related courses from this list.

Training in this field will prepare students for numerous educational opportunities upon graduation, including medical, dental, optometry, veterinary, and graduate school. In addition, numerous positions are available in teaching (for secondary level see Biology track), business, biotechnology, forensics, law, biomedical and basic research, agriculture, and government.

1. Upper-division requirements [must include at least one laboratory course (indicated by *) from either category 1.b) or 2.]
 - a) Required courses (20–24 units)
 - (1) BCH 110A and BCH 110B (recommended) or BCH 100
 - (2) BIOL 102, BIOL 107A, CBNS 101, CBNS 108

b) Additional requirements (a minimum of 20 units from the following list)

Note Credit is awarded for only one of BIOL 109 or BCH 153/BIOL 153/BPSC 153.

(1) Cell Biology: BIOL 109*, BIOL 113, BIOL 114, BPSC 135, CBNS 116, CBNS 120/PSYC 120

(2) Molecular Biology:
BCH 153/BIOL 153/BPSC 153*,
BIOL 107B, BIOL 115,
BIOL 155/BPSC 155

(3) Developmental Biology: BIOL 168, CBNS 169

2. Additional courses from the following to bring total units to 52.

BCH 102*, BCH 120, BCH 162*,
BIOL 104/BPSC 104*, BIOL 110,
BIOL 119, BIOL 121/MCBL 121,
BIOL 121L/MCBL 121L*,
BIOL 123/MCBL 123/PLPA 123,
BIOL 124/MCBL 124, BIOL 128/CBNS 128,
BIOL 132/BPSC 132*, BIOL 138/BPSC 138*,
BIOL 143/BPSC 143*, BIOL 148/BPSC 148*,
BIOL 161A*, BIOL 171, BIOL 171L*, BIOL
191, CBNS 106, CBNS 120L/PSYC 120L*,
CBNS 125/PSYC 125, CBNS 150/ENTX 150,
ENTM 126L*, ENTX 101

Conservation Biology Track

Conservation biology seeks to understand the consequences of the rapid loss of Earth's diversity of life and to preserve biodiversity. Conservation Biology is a multidisciplinary science that applies principles of ecology, population genetics, evolutionary biology, and other sciences to solve problems related to the loss of biodiversity.

The emergence of conservation biology stems from the recognition that Earth's ecological systems face critical problems from rapid growth of human populations and per capita resource consumption. A major focus of the discipline is the study of human impacts on biodiversity, with special emphasis on management processes that prevent species extinctions and ameliorate anthropogenic damage to ecosystems. People rely on a healthy biosphere for most of their basic requirements for food, medicines, chemicals, fibers, and building materials. Ecosystem processes are dependent on biodiversity and are critical for nutrient recycling, degradation of human wastes and pollutants, and maintenance of the chemical composition of the atmosphere. Biodiversity also provides important aesthetic benefits, as well as a vast genetic library that provides vital resources for the developing enterprise of biotechnology.

Students earning a bachelor's degree in Biological Sciences with the Conservation Biology track are trained to help society understand the extent and consequences of biodiversity loss, and to provide objective scientific data to resource managers and social planners. Students who are broadly trained in fields relevant to Conservation Biology, such as ecology, population genetics, evolutionary biology,

and earth or environmental sciences, will be prepared for graduate study and a variety of careers in research, education or environmental consulting and management.

Suggested areas of specialization include ecology, evolution and systematics, and earth or environmental sciences. Because Conservation Biology is broadly interdisciplinary, students are advised to select lower-division courses in humanities and social sciences with an eye to the prerequisite structure of upper-division courses in Geology, Environmental Sciences, Anthropology, or Economics that might form their upper-division specialization.

1. Additional lower-division requirements

a) ECON 006/ENSC 006. This course also satisfies a portion of the breadth requirements in Social Sciences.

b) GEO 002

2. Upper-division requirements [at least 36 units from the following, including two courses with laboratory or field component (indicated by *)]

a) BIOL 102

b) BCH 100 or BCH 110A

c) STAT 100A

d) Breadth Electives (a minimum of one course from each of the following areas)

(1) Evolution and Systematics: BIOL 105, BIOL 108, BIOL 112/BPSC 112/ENTM 112, GEO 151*

(2) Ecology: BIOL 116, BIOL 116L*, BIOL 117, BIOL 127/ENTM 127, BPSC 146*

(3) Biological Diversity:
BIOL 100/ENTM 100*,
BIOL 104/BPSC 104*, BIOL 134/
PLPA 134, BIOL 134L/PLPA 134L*,
BIOL 151*, BIOL 161A*, BIOL 163*,
ENTM 109*, ENTM 114* (may be
applied either to Biological Diversity
or to Applications)

(4) Biogeography and the Physical
Environment: ENSC 100/SWSC 100*,
GEO 152*, GEO 153, GEO 161*,
GEO 162*, GEO 168*, GEO 169*

(5) Applications: ANTH 134,
ANTH 170/BPSC 170,
BIOL 165/BPSC 165*, BIOL 166*,
ECON 143A/ENSC 143A,
ECON 143B/ENSC 143B,
ECON 143C/ENSC 143C, ENTM 114*
(may be applied either to Biological
Diversity or to Applications),
ENSC 172, ENSC 174, GEO 157*,
GEO 167*

3. Specialization: 12 units of upper-division and/or substantive courses in an area of specialization chosen in consultation with a faculty advisor. A maximum of 4 units of 190-series independent study courses may be used to satisfy a portion of the specialization requirement.

4. Additional courses in biological sciences (upper division) and related areas from the approved list to bring total units to 52.

Environmental Toxicology Track

The effect of environmental pollutants on human health and other biological systems, and the impact of human activity on the environment is a growing source of public concern. Consequently, there is an increasing demand on government, industry and academia for scientists trained in a variety of environmental disciplines.

The Environmental Toxicology curriculum fills this need and provides students with a strong foundation in biology and biochemistry, as well as training in environmental toxicology. All Environmental Toxicology track students must complete a series of courses designed to provide a broad, fundamental understanding of environmental toxicology. Graduates will be positioned to pursue careers in environmental toxicology and other environmental life sciences and have the required background for entry into graduate, medical, dental, or veterinary programs.

1. Upper-division required courses (40–44 units)

a) BCH 100 or both BCH 110A and BCH 110B

b) BIOL 102, BIOL 107A or BCH 110C, CBNS 101 or BIOL 113 or BIOL 114, BIOL 116

c) CHEM 136/ENSC 136/ENTX 136 or ENSC 101, ENSC 102

d) CBNS 150/ENTX 150, ENTX 101, ENTX 154

2. Additional upper-division requirements (four courses from the following, with at least one from Chemical Fate and one from Health/Ecology)

a) Chemical Fate: CHEM 005, CHEM 109, CHEM 125, CHEM 135/ENSC 135/ENTX 135, CHEM 150A, CHEM 150B, ENVE 144/ENSC 144, ENSC 100/SWSC 100, ENSC 104/SWSC 104, ENSC 107/SWSC 107, ENSC 127/SWSC 127, ENSC 140/SWSC 140, ENSC 141/MCBL 141/SWSC 141, ENSC 142, ENSC 155, ENSC 163, ENSC 172, ENSC 174, ENSC 176/SWSC 176

b) Health/Ecology: BCH 102, BCH 153/BIOL 153/BPSC 153, BCH 184, BIOL 108, BIOL 109, BIOL 115, BIOL 117, BIOL 121/MCBL 121, BIOL 121L/MCBL 121L, BIOL 124/MCBL 124, BIOL 128/CBNS 128, BIOL 161A, BIOL 161B, BIOL 168, BIOL 171, BIOL 171L, CBNS 106, CBNS 169, ENTM 126, ENTM 128

3. Additional courses in biological sciences (upper division) and related areas from the approved list to bring total units to 52.

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Evolution and Ecology Track

Evolution is the central unifying concept linking all areas of the Biological Sciences. Ecology is the study of the interrelationships and interactions between organisms and their environment that drive adaptation and dictate the distribution and abundance of organisms.

An area of specialization in Evolution and Ecology primarily serves students who are interested in entering graduate school in one of these fields or in directly entering a career in a related area, such as in an environmental consulting firm or local, state, or federal agency that deals with ecological issues.

Students can focus their training to prepare themselves for further graduate study in numerous areas of the Biological Sciences, further study in a number of health related professions (medicine, dentistry, veterinary medicine, optometry), and a biological sciences career within private industry, local, state, or federal government.

1. Upper-division requirements [at least 36 units from the following, including one course with laboratory or field component (indicated by *)]

a) Required courses

- (1) BCH 100
- (2) BIOL 102
- (3) At least three courses from BIOL 105, BIOL 108, BIOL 112/BPSC 112/ENTM 112, BIOL 116, BIOL 160. Courses not used to meet this requirement can be applied to additional requirements.

b) Additional requirements (at least one course from each of the following areas)

- (1) Biological Diversity: BIOL 100/ENTM 100*, BIOL 134/PLPA 134, BIOL 134L/PLPA 134L*, BIOL 151*, BIOL 157*, ENTM 114*
- (2) Functional Biology and Behavior: BIOL 138/BPSC 138*, BIOL 160, BIOL 160L*, BIOL 161A*, BIOL 161B*, BIOL 162/ENTM 162, BIOL 174, BIOL 175, BIOL 178
- (3) Ecology and Evolution: BIOL 105, BIOL 108, BIOL 112/BPSC 112/ENTM 112, BIOL 116, BIOL 116L*, BIOL 117, BIOL 119, BIOL 127/ENTM 127, BIOL 148/BPSC 148, BIOL 165/BPSC 165*, BIOL 163*, BIOL 166*, BPSC 146*

2. Statistics requirement (minimum of one course) STAT 100A, STAT 100B
3. Additional courses in biological sciences (upper division) and related areas from the approved list to bring total units to 52.

Medical Biology Track

The Medical Biology track provides a solid foundation in science and mathematics for students who plan a career in medicine, health sciences or veterinary medicine. The track is also

excellent preparation for graduate research in modern cell and molecular biology and physiology.

Although clinical courses are not part of the curriculum, the track prepares students for specific training for clinical applications in the health sciences, including medicine, veterinary medicine, osteopathic medicine, chiropractic medicine, dentistry, podiatry, optometry, pharmacy, laboratory technology, public health, nursing, physical therapy, nutrition, epidemiology, forensics, hospital administration, and physician's assistant. Additional information and Web sites are provided below (see Suggestions for Elective Units for Medical/Health Professions, Admission Requirements for Medical and Health Professional Schools).

As can be seen from the breadth of courses included in the curriculum of the track, health sciences is a complex and diverse field with much research, new technology and opportunity. It is a major part of the economy of this country, and there is a continuing need for motivated and well-trained workers, teachers, practitioners and researchers in all aspects of the field.

1. Upper-division requirements [at least 52 units from the following, including two courses with laboratory or field component (indicated by *)]

a) Cell/Molecular

- (1) Required courses (15–20 units)
 - BCH 100 or both BCH 110A and BCH 110B
 - BIOL 102 or BIOL 115
 - CBNS 101 or BIOL 113 or BIOL 114
 - BIOL 107A or BCH 110C

- (2) Elective options: BCH 102*, BCH 110B, BCH 110C, BIOL 107B, BIOL 109*, BIOL 155/BPSC 155

b) Physiology/Anatomy (minimum of two courses with lecture component):

- BCH 120, BIOL 161A*, BIOL 161B*, BIOL 171, BIOL 171L*, BIOL 174, BIOL 175, BIOL 178

c) Neuroscience/Pharmacology (minimum of one course with lecture component):

- CBNS 106, CBNS 116, CBNS 120/PSYC 120, CBNS 120L/PSYC 120L*, CBNS 124/PSYC 124, CBNS 125/PSYC 125, CBNS 126/PSYC 126, CBNS 127/PSYC 127, ENTX 101

d) Pathogenesis (minimum of two courses with lecture component)

- (1) Required course: BIOL 121/MCBL 121
- (2) Elective options: BIOL 121L/MCBL 121L*, BIOL 122/MCBL 122, BIOL 123/MCBL 123/PLPA 123, BIOL 124/MCBL 124, BIOL 134/PLPA 134, BIOL 134L/PLPA 134L*, BIOL 159/NEM 159, BIOL 157*,

CBNS 150/ENTX 150, ENTM 126, ENTM 126L*

- e) Genomics/Bioinformatics (minimum of one course): BIOL 107B, BIOL 109* or BCH 153/BIOL 153/BPSC 153* or BCH 162*, BIOL 119, BPSC 148

- f) Immunology (elective option): BIOL 128/CBNS 128

- g) Development/Embryology (elective options): BIOL 168, CBNS 169

- h) Additional elective courses to bring total units to 52: ANTH 170/BPSC 170, BIOL 100/ENTM 100*, BIOL 104/BPSC 104*, BIOL 105, BIOL 108, BIOL 110, BIOL 116, BIOL 116L*, BIOL 151*, BIOL 160, BIOL 160L*, CHEM 109, CS 010, STAT 100B

Microbiology Track

Microorganisms are ubiquitous from the stratosphere to the depths of the ocean. They encompass the greatest metabolic diversity of all life forms. Many are important in conversion of food products, and more yet, in their spoilage. Some produce important medicinal products, while others, the most potent toxins known. Many are beneficial as symbionts to animals and plants, yet others effect their demise. Students earning a B.S. degree in Biological Sciences with the Microbiology track will be trained for technical careers in a broad spectrum of the medicinal, agricultural, biotechnology, and environmental fields as consultants and technicians. Students specializing in the Microbiology track will also be prepared to continue studies at the graduate level, earn teaching credentials, or enter professional schools in medicine, dentistry, or veterinary medicine.

1. Upper-division core requirements (31–32 units)

- a) BCH 110A, BCH 110B; BCH 110C or BIOL 107A

- b) BIOL 102 or BIOL 115, BIOL 121/MCBL 121, BIOL 121L/MCBL 121L, BIOL 157

- c) BIOL 123/MCBL 123/PLPA 123

2. Additional upper-division requirements (at least three courses from the following) BIOL 107B, BIOL 109, BIOL 113, BIOL 114, BIOL 120/MCBL 120/PLPA 120, BIOL 122/MCBL 122, BIOL 124/MCBL 124, BIOL 128/CBNS 128, BIOL 134/PLPA 134, BIOL 134L/PLPA 134L, BIOL 159/NEM 159, CBNS 101, ENSC 141/MCBL 141/SWSC 141, ENSC 155

3. Additional courses in biological sciences (upper division) and related areas from the approved list to bring total units to 52.

Plant Biology Track

The track in Plant Biology is built on the premise that students with training in plant biology

fill unique and diverse niches in academia, industry, medicine, business, law, biotechnology, government and agriculture. The track is a flexible one that can be tailored to an individual's interests and career goals. Students should consult with a faculty advisor to clarify educational goals and to plan an appropriate program of study.

The Plant Biology track can prepare students for a wide array of graduate or professional training programs or employment positions in the fields of agronomy, biochemistry, biotechnology, botany, cell biology, conservation biology, developmental biology, ecology, ethnobotany, evolution, dentistry, genetics, horticulture, medicine, molecular biology, plant breeding, plant pathology, plant physiology, systematics, and veterinary medicine. While Plant Biology is not considered a traditional track for students who plan careers in medicine, veterinary medicine, or dentistry, professional schools may view the individuality of training in plant biology as an asset.

Notes BCH 110A is strongly recommended.

- Upper-division core requirements (28-32 units)
 - BIOL 102
 - BPSC 104/BIOL 104 (may be waived with consent of the faculty advisor)
 - BIOL 132/BPSC 132, BIOL 143/ BPSC 143, BPSC 133
 - At least 8 units from the following:
 - BIOL 100/ENTM 100, BIOL 120/ MCBL 120/PLPA 120, BIOL 120L/ MCBL 120L/PLPA 120L, BIOL 121/ MCBL 121, BIOL 121L/MCBL 121L, BIOL 123/MCBL 123/PLPA 123, BIOL 124/MCBL 124, BIOL 134/ PLPA 134, BIOL 134L/PLPA 134L, BIOL 159/NEM 159, BPSC 134/ ENSC 134/SWSC 134, ENSC 120/ NEM 120/SWSC 120, ENTM 124
 - Two (2) units of BPSC 195H, BPSC 197, BPSC 198-I, or BPSC 199
- Additional upper-division requirements (20 units must come from one of the following four areas of specialization)
 - Plant Cellular, Molecular, and Developmental Biology
 - BPSC 135
 - Additional units from the following to meet the B.S. requirement:
 - BCH 102, BCH 110B, BCH 110C or BIOL 107A, BCH 153/BIOL 153/ BPSC 153, BCH 162, BCH 183, BIOL 107B, BIOL 113, BIOL 114, BIOL 121/MCBL 121, BIOL 121L/ MCBL 121L, BIOL 123/MCBL 123/PLPA 123, BIOL 155/BPSC 155, BIOL 168, CBNS 101, CBNS 108
 - Plant Genetics, Breeding, and Biotechnology

- BPSC 150
- Additional units from the following to meet the B.S. requirement:
 - BCH 153/BIOL 153/BPSC 153, BIOL 105, BIOL 107A, BIOL 107B, BIOL 108, BIOL 109, BIOL 119, BIOL 148/BPSC 148, BIOL 155/ BPSC 155, BPSC 135, BPSC 158, CBNS 108
- Ecology, Evolution, and Systematics
 - BPSC 146
 - Additional units from the following to meet the B.S. requirement:
 - ANTH 170/BPSC 170, BIOL 105, BIOL 108, BIOL 112/BPSC 112/ ENTM 112, BIOL 116, BIOL 116L, BIOL 117, BIOL 138/BPSC 138, BIOL 165/BPSC 165, BPSC 134/ ENSC 134/SWSC 134, BPSC 158, BPSC 166, ENSC 100/SWSC 100, GEO 151
- Plant Pathology, Nematology, and Pest Management
 - BIOL 120/MCBL 120/PLPA 120
 - Additional units from the following to meet the B.S. requirement:
 - BCH 183, BIOL 100/ENTM 100, BIOL 120/MCBL 120/PLPA 120, BIOL 120L/MCBL 120L/PLPA 120L, BIOL 121/MCBL 121, BIOL 121L/ MCBL 121L, BIOL 123/MCBL 123/ PLPA 123, BIOL 124/MCBL 124, BIOL 127/ENTM 127, BIOL 134/ PLPA 134, BIOL 134L/PLPA 134L, BIOL 159/NEM 159, BPSC 133, BPSC 146, BPSC 150, BPSC 158, BPSC 166, ENSC 104/SWSC 104, ENTM 109, ENTM 124, ENTM 129, ENTM 129L, ENSC 100/SWSC 100, ENSC 120/NEM 120/SWSC 120
- Additional upper-division courses in biological sciences and related areas from any of the above lists, and students may apply a maximum of six units of BPSC 190 and/or BPSC 197 and/or BPSC 198-I and/or BPSC 199 to bring total units to 52.

Honors Program

The Honors Program in the Biological Sciences interdepartmental major is designed to provide qualified upper-division students with opportunities to engage in the theory and practice of original research, and to learn the art of written and oral scientific communication.

Prerequisites for the Honors Program

- Submission of an application to the University Honors Program during the spring quarter of the sophomore year or during fall quarter of the junior year
- Junior standing (completion of a minimum of 90 units)

- Minimum GPA requirements or consent of director
 - Cumulative GPA of 3.50
 - A GPA of 3.50 in upper-division major courses

Students who meet the requirements of the University Honors Program for academic excellence are invited at the end of their sophomore year to participate in the Biological Sciences Undergraduate Honors Program during their junior and/or senior years. Students in the program are required to complete BLSC 192H and BLSC 193H, seminar/thesis courses for a total of 4 units. The students are also required to enroll in BLSC 198H and BLSC 195H to work on and complete an honors thesis under the supervision of a faculty member, for a total of 12 units distributed over three to six quarters in their junior and senior years.

Selecting a Track

The requirements of the Life Sciences core curriculum occupy most of the first two years of study; therefore, Biological Sciences majors need not select their area of specialization (track) until the beginning of the junior year. However, if a student desires, a track can be selected earlier. For assistance in selecting a track, a student should consult with a faculty advisor in the area of interest. Consultations of this kind are conducted in the CNAS Academic Advising Center (1223 Pierce Hall). To declare a track or transfer from one track to another, students inform the Advising Center staff.

Comparison of Tracks in Biological Sciences Major with Departmental Majors

Also available at UCR are some departmental majors similar to certain tracks within the Biological Sciences major. The upper-division requirements for the departmental majors in Biology and Plant Biology (see those sections in this catalog) are similar to the requirements in the Biology and Plant Biology tracks, respectively. The Life Sciences core curriculum is required for these departmental majors as with all the tracks in the Biological Sciences major, so students in good standing can easily transfer from one major to another simply by filing the Change of Major form.

A choice of a B.A or B.S. degree is available for the departmental Biology major, whereas only the B.S. degree is offered for the Biology track and all other tracks in the Biological Sciences major. In comparison with the departmental Biology major, the Biology track has a more prescribed selection for the upper-division courses. The Biology major requires genetics (BIOL 102) and an additional 32 upper-division units to be selected from courses on the approved list. The Biology track is intended to ensure a breadth of course work in life sciences in contrast to the other more specialized

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tracks in the Biological Sciences major. As described below, the 36 units of upper-division courses for the Biology track must include at least two laboratory or field courses, three courses in the cell/molecular area (including genetics), two courses in the functional biology of organisms, and two courses in the integrated fields of ecology/evolution/systematics/behavior.

The departmental Plant Biology major differs from the Plant Biology track primarily in offering a B.A. option in addition to the B.S. option. The upper-division course requirements are identical for the departmental major and the Plant Biology track.

Enrollment Options and Advising

The CNAS Academic Advising Center (1223 Pierce Hall, [951] 827-3579) is the advising office for all students majoring in Biology, Biological Sciences, Plant Biology, and Neuroscience. The CNAS Academic Advising Center is open Monday through Friday, 9 a.m. to noon and 1 to 4 p.m. Faculty advisors are usually available for advising Tuesday through Friday, 10 a.m. to noon and 1 to 3 p.m.

Advising is on a walk-in basis. Students sign in at the counter indicating what is needed. A quarterly schedule, available at the counter, lists faculty advisors, their advising hours, and areas of specialization.

Prospective, new, and continuing students considering enrollment in the above majors are welcome to visit or phone the CNAS Academic Advising Center. Information is provided about the majors, policies and procedures, and course enrollment. Petitions and other related business requiring a signature or approval are routed through the CNAS Academic Advising Center.

Students visit the CNAS Academic Advising Center as needed, but those in academic difficulty are especially urged to meet with a faculty advisor to review study procedures and plan a program of study to correct deficiencies and achieve academic success. With informational handouts and advising, all students are urged to create a long-range academic plan so that course prerequisites are met and courses are taken in the best possible sequence for the individual's interests, aptitude, and career goals. Note that a course load of approximately 16 units per quarter is required for normative progress toward the degree.

Grading Basis: Letter Grade or Satisfactory (S)/No Credit (NC)

Students must enroll for letter grade credit in science and mathematics courses used to satisfy major requirements. This includes all courses in the Life Sciences core curriculum, the 36 upper-division units for the major, and the 16 units of substantive course work related to the field of the major. After completion of the core requirements and upper-division requirements for the major, science and mathematics courses counted as electives may be taken on a Satisfactory (S)/No Credit (NC) basis.

Basic Writing and English Composition (ENGL 00IA, ENGL 00IB, ENGL 00IC) may be taken on an S/NC basis, but this is strongly not recommended. English composition is essential and so important that students should aim for excellence rather than a satisfactory level of achievement. Foreign language courses may be completed on an S/NC basis, but this is also not recommended. Since language courses are often taken in series, progress is cumulative, and students may fall behind if only a satisfactory level is attempted in early courses in the sequence.

For policies on S/NC grading, see the Academic Regulations section of this catalog.

Full- or Part-time Study

Students ordinarily enroll full-time in 12 to 18 units of course work each quarter. Advisor approval is required for exceptions. The dean's approval is required for any change in the academic program that reduces enrollment below 12 units for the quarter. Students who are unable to enroll full-time because of health, family responsibilities, or outside employment may apply to the CNAS Academic Advising Center (1223 Pierce Hall) for permission to enroll part-time. Documentation of hours of employment is required. Part-time students may take no more than 10 units in one quarter, and they receive a 50 percent reduction in the Educational Fee for that quarter.

Minor

The Biological Sciences major does not offer a minor in Biological Sciences, but seven disciplinary minors (Applied Statistics, Botany and Plant Sciences, Chemistry, Entomology, Environmental Sciences, Mathematics, Neuroscience, Physics) are offered by departments within the College of Natural and Agricultural Sciences. Interested students are referred to those sections of this catalog. Other available minors include Computer Science in the College of Engineering, and more than 40 minors in the College of Humanities, Arts and Social Sciences.

For students enrolled as a Biological Sciences major, a minor added to the program must be in an area that is distinctive and different from the chosen track (e.g., a minor in Botany and Plant Sciences is not permitted with the track in the same field).

Double Major

A double major can be completed with a track in Biological Sciences and another major, as long as the chosen majors are in distinct and different fields. Biological Sciences can be either the first (primary) or second major, depending on which one is chosen for matriculation and emphasis. The Life Sciences core curriculum and requirements for one of the tracks in Biological Sciences must be completed. Completion of two tracks within Biological Sciences does not count as a double major since both tracks are within the same major.

Double majors are not allowed between certain tracks in Biological Sciences (Biology, Plant Biology) and the similar departmental major in the same field (Biology and Plant Biology). Some or all of the requirements may be completed for more than one track, but only one track will be approved for inclusion on the transcript.

Transfer Students

Students planning to transfer to UCR with a major in Biological Sciences, Biology, or Plant Biology must have "C" or higher grades in general chemistry (item 1, below) and at least two of the remaining sequences in the recommended priority 2, 3, 4, 5. This is a minimal course requirement for transfer to the above majors from community colleges and four-year colleges and universities, but all five sequences are necessary for graduation in these majors at UCR. Transfer students will usually find it advantageous to complete most or all sequences before starting at UCR. All prospective transfers should try to complete the sequences they begin rather than divide a sequence between two campuses.

1. General chemistry, equivalent to CHEM 001A, CHEM 001B, CHEM 001C, CHEM 01LA, CHEM 01LB, CHEM 01LC
2. First-year calculus, equivalent to MATH 009A, MATH 009B
3. Introductory biology (for science majors), equivalent to BIOL 005A, BIOL 05LA, and BIOL 005B (and BIOL 005C, if available)
4. Organic chemistry, equivalent to CHEM 112A, CHEM 112B, CHEM 112C
5. General physics with laboratory equivalent to PHYS 002A, PHYS 002B, PHYS 002C (and PHYS 02LA, PHYS 02LB, PHYS 02LC) or PHYS 040A, PHYS 040B, PHYS 040C. Calculus is a prerequisite for both the PHYS 002 and PHYS 040 sequences.

To be eligible to transfer into one of the above majors, students must also have a minimum GPA of 2.70 in transferable college courses.

If the equivalents of BIOL 005A, BIOL 05LA, and BIOL 005B are not accessible prior to transfer, students are strongly recommended to complete organic chemistry and take the BIOL 005 sequence at UCR rather than the equivalent of BIOL 002 and BIOL 003 (introductory biology for nonscience majors) before transfer.

Completion of calculus is strongly recommended before transfer. If sequences 1-3 are completed, students are also encouraged to complete one year of organic chemistry with laboratory (for which a one-year general chemistry series is a prerequisite). Partial satisfaction of the breadth requirements (e.g., English, humanities, arts, social sciences, and ethnic studies) also accelerates the student's progress, but priority should be given to the above mathematics and science sequences.

UCR has articulation agreements with most of the California community colleges. These agreements list specific community college courses that have been designated as comparable to UCR courses (see the statewide articulation Web site at www.assist.org).

To integrate transfer credits with a program of study at UCR, it is important that all new transfer students consult with an advisor before or early in their first quarter on campus. Prospective UCR students are welcome to discuss their past and future academic program with an advisor. Phone the CNAS Academic Advising Center, (951) 827-3579, to arrange an appointment.

Independent Study and Research

The various departments and programs in the College of Natural and Agricultural Sciences offer courses in which students can enroll to do independent laboratory or field research or an in-depth library study of a topic of special interest. These courses are numbered 194-199 and usually have variable unit credit allowing for differences in emphasis and time available for research in the student's academic program.

The departments have different names and policies for the 190-series courses: Independent Reading, Introduction to Research, Research for Undergraduates, Junior/Senior Research, Senior Research, Senior Honors Research. Interested students should consult with 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 from the CNAS Academic Advising Center (1223 Pierce Hall).

The procedure for enrolling in these courses depends on the policies of the department or academic unit sponsoring the research. For BIOL 194, BIOL 197 and BIOL 199, the student must obtain an application form from the CNAS Academic Advising Center. Instructions for writing a brief description of the proposed project are provided with the form. The completed application, signed by the professor in charge of the project, is submitted to the CNAS Academic Advising Center preferably before the first day of the quarter but no later than the end of the second week of the quarter. Applicants for independent research should ordinarily be sophomores, juniors or seniors in good standing and achieving well in their academic program.

Courses numbered 194, 197, 199 and 199H may be taken for a letter grade or "S/NC" depending on the department or program offering the course. Up to 9 units of credit in the 190 series may be counted as part of the 16 substantive units related to the major for the B.S. degree.

Internships

Internships provide students with practical, part-time work experiences in conjunction with their academic studies. The internships are designed to relate a student's academic preparation in the major with professional work at the entry level in community businesses and organizations. They can be one or more quarters in duration. For more information or to arrange an internship, see the Internship Coordinator in Career Services (Veitch Student Center).

As much as possible, the internships are arranged to accommodate the student's specific interests. Students majoring in Biological Sciences (or Biology, Plant Biology, Neuroscience) commonly work in local hospitals, clinics, museums and medical research laboratories. Some students do internships in health administration, environmental planning and natural resource management. Those considering high school teaching as a possible career can work as tutors or teacher's aides in local high schools (e.g., EDUC 100).

Students majoring in Biological Sciences are welcome to participate in the internship program, but they are not paid for this work. Academic credit is not awarded unless a faculty advisor approves, and the student is enrolled in a 198 course in the College of Natural and Agricultural Sciences. Students frequently find internships helpful in investigating a possible career, and some experience in the work environment is helpful or required for admission to professional and technical training schools.

Teaching Credential

Teachers in the public schools of California must be certified by the California Commission on Teacher Credentialing (CCTC). The credential requires an undergraduate major, baccalaureate degree, and completion of a graduate credential program such as that offered by the Graduate School of Education at UCR (see Education section, Credential Programs, in this catalog). The latter usually requires three quarters and includes education courses and supervised teaching.

Before admission and student teaching in a graduate credential program, candidates must pass the California Basic Education Skills Test (CBEST) and demonstrate subject-matter proficiency in the fields in which they will teach. Candidates can demonstrate proficiency either by passing the commission's subject-matter assessment examination (CSET), or by completing an undergraduate program that is CCTC approved for teacher preparation.

For students in Biological Sciences and all other majors at UCR, this campus has a CCTC-approved undergraduate program leading to a Multiple Subjects Credential and teaching in the elementary (K-6) grades. A breadth of course work is necessary in addition to the specified requirements for the major. Students are urged to start early, preferably as freshmen,

selecting courses most helpful for this career. Students who want a Multiple Subjects Credential must pass the subject-matter proficiency examination (CSET, Multiple Subjects).

UCR does not have a CCTC-approved undergraduate program for Biological Sciences or other science majors who wish to teach at the secondary level. The single-subject, Teaching Credential in Science, biology emphasis, is required for biology teachers, grades 7-12, and adults. Students who plan to get this credential must take the CSET and should make certain that their academic program includes preparatory course work. This is most easily achieved with the breadth of courses required in the Biology track of the Biological Sciences major, but other tracks or majors may be used, provided there is sufficient breadth to pass the CSET exam.

For the Teaching Credential in Science with emphasis in biology, the subject-matter examination (CSET) includes 1) biology/life science in depth and 2) general science with introductory, college-level biology, chemistry, physics, and geoscience (geology, meteorology, oceanography, astronomy). Introductory biology, chemistry, and physics are included in the Life Sciences core curriculum, but some additional course work in geoscience should be taken to strengthen preparation in this area. The intent is that candidates for the Teaching Credential in Science are prepared to teach unifying themes and principles in general and specialized science courses.

There are other credential options (e.g., BCLAD) and requirements that may be completed during the undergraduate years. Requirements include knowledge of the U.S. Constitution and courses in health (EDUC 044), cardiopulmonary resuscitation, and mainstreaming (EDUC 116). Additional information is provided in orientation meetings and the Graduate School of Education (1124 Sproul Hall; www.education.ucr.edu/teach).

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 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 to promote planning and professional development towards a science/mathematics education career.

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For more information about the CaTEACH-SMI program, please visit <http://smi.ucr.edu> or at the Resource Center at 1104 Pierce Hall.

Preparation for Graduate School

All the tracks in the Biological Sciences major and the departmental majors in life science (Biology, Plant Biology, Entomology, Neuroscience) are appropriate as preparation for those planning to attend graduate school for advanced degrees (Master's, Ph.D.). The faculty advisor assists in selecting combinations of courses appropriate for advanced study in the various fields of biology. Students considering graduate study are encouraged to do undergraduate research and include courses in computer science and statistics in their program.

The campuses and departments of the UC set their own requirements for admission to graduate school, but students should expect that at least a "B" average is required to be eligible for consideration. Higher levels are usually necessary for applicants to be competitive for admission as well as financial assistance (e.g., graduate fellowship, teaching assistantship). Letters of recommendation, undergraduate research, and results on the nationwide Graduate Record Examination are also considered. A minimum GPA of 2.50 in the last 60 units of undergraduate course work is necessary to be eligible for admission to master's degree programs in the California State University system, but campuses and departments usually have additional or higher requirements.

Preparation for Medical/Health Professions or Veterinary Medicine

Suggestions for Elective Units Students must complete a minimum of 180 units for a bachelor's degree at UCR, and each of the nine tracks in the Biological Sciences major and the departmental majors in life science have some unit space for elective courses. Depending on the courses chosen to meet other requirements, about 30 elective units remain among the 180 units required for graduation, after completion of English composition, humanities and social sciences breadth courses, the Life Sciences core curriculum, and the 52 upper-division and substantive units in the field of the major. Students planning a career in medicine or health science or other areas should give careful consideration to the use of their elective units to add breadth, perspective, and practical experience as part of the preparation for the professional schools and careers they have chosen. The following suggested activities were prepared after consultation with some medical school representatives.

Communication Skills, Internships, Volunteer Work Interaction with co-workers and patients is an integral part of health care professions. Students planning a career in this area need excellent social and communication skills and leadership experience. Patients must have confidence in the competence and judgment of medical professionals and know that

recommendations and decisions are being made for the patient's benefit. Experiences that broaden understanding of the human condition and/or increase sensitivity towards the medically underserved will increase an applicant's chances for admission to medical school or other health professional programs.

As interest, time, and units permit, students should take more than the minimum required courses in English, humanities, arts, and social sciences. Volunteer work in health care facilities and community service agencies provides valuable experience and helps students clarify career interests and goals. EDUC 100 (2 units) can be taken for tutoring in the public schools, and coordinators in Career Services (Veitch Student Center) arrange for internships in local clinics, hospitals, laboratories, and community centers.

Foreign Language, Study Abroad There is much ethnic diversity in California and the United States, so proficiency in a foreign language (e.g., Spanish) is highly desirable for health care workers. Participation in the Education Abroad Program (EAP) is encouraged (see the EAP section of this catalog). Students interested in the language, literature, science, art, culture, history, government, or social institutions of the EAP countries have the opportunity to learn from first-hand experiences. Opportunities are available at each level, but the traditional year abroad is generally taken in the junior year. Short-term (one quarter or less) options are available in selected countries in numerous academic fields. Search for programs by specific areas at eap.ucop.edu/programwizard.

Minor, Second Major Students succeeding in their primary major may wish to add a minor or second major to the academic program. More than 40 minors are offered in the College of Humanities, Arts and Social Sciences, seven in the College of Natural and Agricultural Sciences, and one (Computer Science) in the College of Engineering. Additional lower- or upper-division course work, a minor or second major in a field distinct from the primary major adds breadth and individuality to the academic program and shows that the student has interest and proficiency beyond the field of the major. Information about minors and second majors is provided in other sections of this catalog.

Expected Level of Computer Proficiency Rapid changes and improvements in the health science field are occurring as a result of new technology and discoveries. Computers and complex instrumentation are routinely used in clinics and laboratories, so it is necessary to have computer skills and experience with lab equipment as provided in laboratory or field science courses. Undergraduates planning a career in medicine or other areas of science must have a knowledge of computer operating systems, word processing, spreadsheets, databases, E-mail, and the Internet. For those who have not reached this level of proficiency, CS 008 (Introduction to Computing, 4 units) is available as an elective.

Genomics and Bioinformatics These new research fields, along with clinical applications of proteomics, are having an increasing impact on all aspects of medical practice, including diagnosis, treatment and delivery of services. Information derived from these fields is included in the Life Sciences core and upper-division science courses, and students may wish to include more than the minimum requirement as part of their undergraduate and postgraduate studies.

Independent Study and Research Independent study is encouraged for future workers in medicine and other science research areas, and the various departments and programs on campus offer courses (numbered 194, 197, 199, 199H) in which students can enroll to do independent laboratory and/or field research or an in-depth library study of a topic of special interest. Students desiring to do such independent work should consult with a professor who is willing to supervise the project.

Admission Requirements for Medical and Health Professional Schools Most of the course work required for admission to professional schools is met by 1) the UCR requirements in English composition, humanities, arts, and social science and 2) the core curriculum for the various life science majors and tracks. Professional schools commonly require biochemistry, differential and integral calculus (MATH 008B or MATH 009A, MATH 009B), statistics (e.g., STAT 100A), some computer proficiency (e.g., CS 008), and one year of each of the following (with lab): introductory biology, inorganic chemistry, organic chemistry and physics.

Most schools require one or two years of college-level biology or zoology classes without specifying certain courses. Some schools, however, do require or highly recommend specific courses. Because of the amount and complexity of information in medical science, undergraduate students are urged to acquire strong preparation in major areas (e.g., biochemistry, genetics, microbiology, vertebrate anatomy and physiology, cell and molecular biology) so that they will not be overwhelmed with new information in professional school.

Information about required course work and admission tests (DAT, MCAT, VCAT, PCAT, GRE), can be obtained from Career Services (Veitch Student Center) and the Medical and Health Careers Program (visit 1114 Pierce Hall or mhcp.ucr.edu). Students must attend one orientation meeting prior to making an individual appointment at the Medical and Health Careers Program office. Several meetings are available each quarter (the schedule is available on the Web site or from 1114 Pierce Hall or 1223 Pierce Hall).

Joint UCR/UCLA Medical School Each year, 24 students at UCR are selected for admission to the UCR/UCLA medical school (Thomas Haider Program in Biomedical Sciences). For the classes starting medical school Fall 2006 and later, eligible students in Medical Biology and other tracks and majors at UCR can complete

the admission requirements and apply for the 24 positions reserved for UCR students. The first two years of medical school are taken at UCR, while the next two (clinical) years are completed at medical facilities at or associated with UCLA (Geffen School of Medicine). Information about course work and other admission requirements for the UCR/UCLA medical program are provided at www.biomed.ucr.edu, under Biomedical Sciences in this catalog, at the Student Affairs Office for the program (B600 Statistics-Computer) and in orientation meetings held at UCR.

Other Medical Schools, Osteopathic Medicine, Pharmacy, Dentistry, Optometry, Podiatry

A national organization for each medical profession publishes admission requirements, enrollment data and the curriculum for each school in that profession. The *Medical School Admission Requirements* book is usually available in the UCR Bookstore. Publications that outline requirements for other professional schools may be ordered from the bookstore, and they are available in Career Services (Veitch Student Center).

The most commonly required or recommended courses for professional schools in the above areas are biochemistry, genetics, cell and molecular biology, embryology or development, and (for pharmacy, optometry) human anatomy and physiology. Most professional schools require that physics, chemistry and other science courses be taken with laboratory if possible. Some dental and optometry schools require one or two courses in psychology (e.g., PSYC 001, PSYC 002). Some dental schools require principles of management (e.g., BUS 010). Helpful electives for dental school include economics, social science, nutrition, and basic accounting.

Some medical schools recommend physical chemistry (e.g., CHEM 109) and one year of college-level mathematics (e.g., MATH 005, MATH 008B or MATH 009A, and MATH 009B or the MATH 009A, MATH 009B, MATH 009C sequence). Medical schools usually do not offer substantive instruction in parasitology, so students can gain lecture and laboratory strength in this area by including BIOL 157 in the undergraduate program.

The Medical College Admission Test (MCAT), Dental Admissions Test (DAT), and tests for other health professions are commonly taken in the spring or summer of the junior year, so chemistry, physics, mathematics and some upper-division courses (e.g., biochemistry, genetics, cell and molecular biology, vertebrate anatomy and physiology) should be completed as much as possible before the exam is taken. The medical schools strongly urge applicants to complete the MCAT by April of the year in which they are applying so that evaluation of the application will not be delayed.

Veterinary Medicine The UC Davis School of Veterinary Medicine requires a course in statistics (e.g., STAT 100A), genetics (e.g.,

BIOL 102), physiology (e.g., BIOL 171 and BIOL 171L) and embryology or development (e.g., BIOL 168, CBNS 169). The Western University of Health Sciences (Pomona, CA) requires the following for admission to its School of Veterinary Medicine: microbiology (BIOL 121/MCBL 121, BIOL 121L/MCBL 121L), nutrition (e.g., BCH 010), genetics (BIOL 102), computer skills (e.g., CS 008), technical writing (e.g., ENGL 01SC), public speaking (THEA 050) and macroeconomics (e.g., ECON 002).

Physical Therapy, Physician's Assistant, Public Health, Nutrition, Nursing, Occupational Therapy, Dental Hygiene

In most of the schools that have specializations in these areas, the clinical/professional training is at the graduate level. Preparatory course work and a baccalaureate degree can be obtained at UCR, with application to the desired graduate program. Each professional school may have specific requirements that must be met in the undergraduate years, in addition to the courses required for all UCR biology students (e.g., English composition, humanities and social sciences, science and mathematics core curriculum). In their second or third year at UCR, students interested in the above professional schools and careers should attend one of the orientation meetings held by the Medical and Health Careers Program Advisor. Practical volunteer or paid work experience is required or helpful for admission to these programs, especially physical therapy and physician's assistant. Visit the internship coordinator (Career Services, Veitch Student Center) to arrange volunteer work at local institutions.

For some of the above specializations, clinical training is provided as part of an undergraduate curriculum. For a certificate or baccalaureate degree in nursing, nutrition, dental hygiene, or physician's assistant, students are well-advised to enroll initially in a school with the specific undergraduate program they want. Students can take some of the preparatory course work (e.g., English composition, introductory biology, chemistry) at UCR for such programs and then transfer, but this may increase the overall time to get the certificate or degree. Students wishing to obtain their degree at UCR before transferring should select additional upper-division course work in biology and related fields appropriate for the desired professional school and career objective.

Laboratory Technology Students who plan to apply to a laboratory technology school must obtain a Clinical Laboratory Scientist Trainee license, which certifies that they have completed the required courses for admission to a training program. In addition to the courses required in the core curriculum, the following courses are required by the California State Department of Health for a trainee license in Clinical Laboratory Science:

Biochemistry: BCH 100 or BCH 110A

Microbiology: BIOL 121/MCBL 121, BIOL 121L/MCBL 121L, BIOL 124/MCBL 124

Immunology: BIOL 128/CBNS 128

Human anatomy/physiology: BIOL 171, BIOL 171L

Quantitative analysis: CHEM 005

Hematology

Students should inquire at the CNAS Academic Advising Center (1223 Pierce Hall) concerning hematology, since a separate course is not available at UCR.

For admission to training laboratories approved by the American Medical Association, students must have one year of organic chemistry. This is completed as part of the core curriculum for the life science majors and tracks. Statistics (e.g., STAT 100A, STAT 100B) and parasitology (BIOL 157) are strongly recommended. Preparation is further strengthened with courses in cell and molecular biology (e.g., BIOL 107A, CBNS 101).

The Medical and Health Careers Program Advisor and Career Services staff can provide information about laboratory technology schools. For current information regarding requirements for clinical training and applications for the Clinical Laboratory Scientist Trainee License (required for admission to any laboratory technology program), students should call (510) 873-6327, or write State of California Department of Health, Laboratory Field Services, 2151 Berkeley Way, Annex 12, Berkeley, CA 94704.

Education and Research Centers, Institutes, and Resources

Undergraduate students benefit greatly from the rich variety of centers, institutes, natural reserves and other research facilities that are part of UCR. Each center or institute has research and teaching focused on a specific area of science or engineering or a specific aspect of culture, behavior, or society. Faculty associated with these resources provide courses, field trips and opportunities for undergraduate research and part-time employment. The Research Opportunities section of this catalog has information and Web sites for the examples below and other centers and institutes at UCR.

Center for Ideas and Society:

IdeasAndSociety.ucr.edu

UC Institute for Mexico and the United States:

ucmexus.ucr.edu

Center for Conservation Biology: ccb.ucr.edu

UCR Institute for Integrative Genome Biology:

genomics.ucr.edu

Center for Plant Cell Biology: cepceb.ucr.edu

UCR Botanic Gardens: gardens.ucr.edu

UCR Natural Reserve System:

biology.ucr.edu/about_us/nrs.html

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Upper-Division Courses

BLSC 192H. Junior Honors Seminar (2) Seminar, 2 hours. Prerequisite(s): junior standing in the Biological Sciences major; admission to the upper-division University Honors Program or consent of instructor. Involves presentations of research programs by individual faculty members; discussions of readings provided by faculty members; research conceptualization and design, and written and oral scientific communication methods; and peer exchanges and peer mentoring. Satisfactory (S) or No Credit (NC) grading is not available.

BLSC 193H. Senior Honors Seminar (2) Seminar, 2 hours. Prerequisite(s): senior standing in the Biological Sciences major; admission to the upper-division University Honors Program or consent of instructor. Discussion of senior thesis writing procedures, including data analysis and presentation, and written and oral scientific communication methods by faculty who are sponsoring honors thesis research. Satisfactory (S) or No Credit (NC) grading is not available.

BLSC 195H. Senior Honors Thesis (1-4) Thesis, 3-12 hours. Prerequisite(s): BLSC 198H; senior standing in the Biological Sciences major; admission to the upper-division University Honors Program or consent of instructor. Students complete research in the biological sciences and write a senior honors thesis under the guidance of a faculty member of the Biological Sciences interdepartmental major. Satisfactory (S) or No Credit (NC) grading is not available. Course is repeatable to a maximum of 9 units.

BLSC 198H. Junior Honors Research (1-4) Laboratory, 3-12 hours. Prerequisite(s): junior standing in the Biological Sciences major; admission to the upper-division University Honors Program or consent of instructor. Students investigate special problems and conduct research in the biological sciences under the guidance of a faculty member of the Biological Sciences interdepartmental major. Satisfactory (S) or No Credit (NC) grading is not available. Course is repeatable to a maximum of 9 units.

Biology

Subject abbreviation: BIOL
College of Natural and Agricultural Sciences

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Professors

Michael F. Allen, Ph.D. (Biology/Plant Pathology)
Richard A. Cardullo, Ph.D.
Mark A. Chappell, Ph.D.
Daphne Fairbairn, Ph.D.
Theodore Garland, Jr., Ph.D.
Leah T. Haimo, Ph.D.
Cheryl Y. Hayashi, Ph.D.
Bradley C. Hyman, Ph.D.
Dmitri Maslov, Ph.D.
Leonard P. Nunney, Ph.D.
David N. Reznick, Ph.D.
Derek A. Roff, Ph.D.
John T. Rotenberry, Ph.D.
Mark S. Springer, Ph.D.
Timothy P. White, Ph.D.
Marlene Zuk, Ph.D.

Professors Emeriti

Carlton R. Bovell, Ph.D.
Kenneth W. Cooper, Ph.D.
Roger D. Farley, Ph.D.
Wilbur W. Mayhew, Ph.D.
Edward G. Platzer, Ph.D. (Biology/Nematology)
Mary V. Price, Ph.D.
Rodolfo Ruibal, Ph.D.
Clay A. Sassaman, Ph.D.
Irwin W. Sherman, Ph.D.
Nickolas M. Waser, Ph.D.

Associate Professors

John Gatesy, Ph.D.
Kimberly A. Hammond, Ph.D.
Morris F. Maduro, Ph.D.
Wendy G. Saltzman, Ph.D.

Assistant Professors

Douglas Altshuler, Ph.D.
Kurt Anderson, Ph.D.
Helen M. Regan, Ph.D.
Joel L. Sachs, Ph.D.

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Lecturer

Tracy L. Kahn, Ph.D.

Cooperating Faculty

Khaleel Abdulrazak, Ph.D. (Psychology)
Edith B. Allen, Ph.D. (Botany and Plant Sciences)
James G. Baldwin, Ph.D (Nematology)
Ring T. Carde, Ph.D (Entomology)
Paul DeLey, Ph.D (Nematology)
Mary L. Droser, Ph.D (Earth Sciences)
Norman C. Ellstrand, Ph.D. (Botany and Plant Sciences)
J. Daniel Hare, Ph.D (Entomology)
John M. Heraty, Ph.D (Entomology)
Nigel C. Hughes, Ph.D (Earth Sciences)
Darrel Jenerette, Ph.D. (Botany and Plant Sciences)
Seung-Chul Kim, Ph.D. (Botany and Plant Sciences)
Sang-Hee Lee, Ph.D. (Anthropology)
Timothy D. Paine, Ph.D (Entomology)
Richard A. Redak, Ph.D (Entomology)
Louis Santiago, Ph.D. (Botany and Plant Sciences)
Richard Stouthamer, Ph.D (Entomology)
William E. Walton, Ph.D (Entomology)

Major

The Department of 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 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, faculty advisors are available in the CNAS Academic Advising Center (1223 Pierce Hall, (951) 827-7294). 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 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).

UCR/UCLA Thomas Haider Program in

Biomedical Sciences Students in this major and all others at UCR are eligible to complete admission requirements and apply for the 24 positions reserved for UCR students in the joint UCR/UCLA Thomas Haider Program in Biomedical Sciences. The first two years of medical school are taken at UCR, while the next two (clinical) years are completed at medical facilities at or associated with UCLA (Geffen School of Medicine). Information is provided at www.biomed.ucr.edu, in the program's section of this catalog, in the Student Affairs Office for the program (B600 Stat-Comp, (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 a department advisor for course planning.