Francisco J. Ayala School of Biological Sciences

On This Page:

• Overview
• Biological Sciences Degrees
• Honors
  • Biological Sciences Honors
  • Scholarships, Prizes, and Awards
• Special Programs and Courses
• Special Research Resources
• Advising: Academic, Career, Health Sciences

Frank Laferla, Hana and Francisco J. Ayala Dean
5120 Natural Sciences II
http://www.bio.uci.edu/

Undergraduate Counseling: 949-824-5318
Graduate Programs:

• Department of Ecology and Evolutionary Biology: 949-824-4743
• Combined Graduate Program in Cellular and Molecular Biosciences (CMB): 949-824-8145
• Department of Neurobiology and Behavior: 949-824-8519

Overview

This is the ideal time to be studying biology. We are solving problems today whose solutions were unimaginable even a few years ago, and implications for our society, our health, and our environment are profound. The Francisco J. Ayala School of Biological Sciences is dedicated to providing students with a unique course of study that fosters a deep appreciation for the exciting facts and concepts in the field, an education that allows graduates to excel in their chosen careers.

The School has recently redesigned the curriculum to remain on the cutting edge of biological education. All first-year students are introduced to basic concepts in ecology and evolutionary biology, as well as cellular and molecular biology. The core set of courses in biology continues into the second year, featuring genetics, biochemistry, and molecular biology, followed in the third and fourth year by a choice of advanced courses in biology. Since biology is a laboratory discipline, students complete a series of laboratory courses in which they learn both the techniques and approaches needed to solve problems in biology.

Finally, the faculty expect that most students will engage in cutting-edge research in one of more than 250 laboratories and medical clinics in the Francisco J. Ayala School of Biological Sciences and the UCI School of Medicine. It is in these situations that faculty train students to think in a sophisticated way about real-world problems. There is also no feeling of excitement greater than finding out something about the world that no one has ever known before, a feeling afforded in biology only by participation in research. The Excellence in Research Program allows students to present their work and be recognized for their performance with a series of awards and publication of their reports in the School’s online Journal of Undergraduate Research.

The set of core classes that instructs students in the concepts of biology, the advanced classes that allow a deep understanding of specialized aspects of biology, the laboratory courses that convey the practical aspects of problem-solving in biology, and the research experiences that engage students in the real excitement in revealing new information about biology, come together to provide an extraordinary experience for students. The Honors Program in the Francisco J. Ayala School of Biological Sciences further enhances the educational experience for the best students.

Biology students have the option of specializing in areas of biology that best fit their interests, completing courses for degree programs in Biochemistry and Molecular Biology, Biology/Education, Developmental and Cell Biology, Ecology and Evolutionary Biology, Genetics, Microbiology and Immunology, or Neurobiology.

Those students who wish to receive a broader education in the area can opt to complete a major in Biological Sciences. Completion of any of these majors forms an excellent basis for application to either graduate or professional studies such as medical school, and graduates of the Francisco J. Ayala School of Biological Sciences are routinely accepted to the most prestigious programs in the country.

The quality of the faculty in the Francisco J. Ayala School of Biological Sciences has remained high while increasing steadily in number over the past few years, giving students a remarkable range of expertise in biology and with it, a large number of different advanced courses and research opportunities. In addition, their efforts have brought several high-impact research units to the campus, such as the Center for the Neurobiology of Learning and Memory, the Center for Virus Research, the Beckman Laser Institute, the Cancer Research Institute, the Developmental Biology Center, the Center for Immunology, the Institute for Memory Impairments and Neurological Disorders, the Macromolecular Structure Research Unit, the Organized Research Unit in Molecular and Mitochondrial Medicine and Genetics, the Institute for Genomics and Bioinformatics, and the Reeve-Irvine
Research Center, all of which are accessible to undergraduates. The Francisco J. Ayala School of Biological Sciences also has close research and teaching collaborations with faculty in the Schools of Medicine, Physical Sciences, Social Ecology, and Social Sciences; the Donald Bren School of Information and Computer Sciences; and The Henry Samueli School of Engineering.

In addition to the regular University requirements for admission, students interested in the biological sciences should include in their high school curriculum, in addition to a course in biology, four years of mathematics, as well as courses in chemistry and physics, which are now an integral part of most contemporary biological work.

The School’s professional counseling staff is always available for consultation to students regarding the many decisions in their academic program. They also are trained to provide guidance in the application process to both professional and graduate schools, a real advantage to the high proportion of students in the Francisco J. Ayala School of Biological Sciences who go on to pursue advanced degrees.

Opportunities are available at the graduate level to specialize in Developmental and Cell Biology, Ecology and Evolutionary Biology, Molecular Biology and Biochemistry, and Neurobiology and Behavior.

### Degrees

<table>
<thead>
<tr>
<th>Degree</th>
<th>Degree Type</th>
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<tbody>
<tr>
<td>Biochemistry and Molecular Biology</td>
<td>B.S.</td>
</tr>
<tr>
<td>Biological Sciences</td>
<td>B.S., M.S., Ph.D.</td>
</tr>
<tr>
<td>Biological Sciences and Educational Media Design</td>
<td>M.S.</td>
</tr>
<tr>
<td>Biology/Education</td>
<td>B.S.</td>
</tr>
<tr>
<td>Biotechnology Management*</td>
<td>M.S.</td>
</tr>
<tr>
<td>Developmental and Cell Biology</td>
<td>B.S.</td>
</tr>
<tr>
<td>Ecology and Evolutionary Biology</td>
<td>B.S.</td>
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<tr>
<td>Exercise Sciences</td>
<td>B.S.</td>
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<td>Genetics</td>
<td>B.S.</td>
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<td>Human Biology</td>
<td>B.S.</td>
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<tr>
<td>Microbiology and Immunology</td>
<td>B.S.</td>
</tr>
<tr>
<td>Neurobiology</td>
<td>B.S.</td>
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</tbody>
</table>

* Offered jointly with The Henry Samueli School of Engineering and The Paul Merage School of Business.

### Honors

**Honors Program in the Francisco J. Ayala School of Biological Sciences**

The Honors Program in the Francisco J. Ayala School of Biological Sciences provides an opportunity for outstanding majors in the School to pursue advanced work in independent research via participation in the Excellence in Biological Sciences Research Program and earn Honors in Biological Sciences upon graduation. Admission to the program is based on an application to participate in the Excellence in Biological Sciences Research program filed during the middle part of the fall quarter of the year of the student’s participation. Additionally, students must have a minimum overall 3.5 grade point average and a minimum 3.5 grade point average in all required Biological Sciences courses. The Program requires enrollment in research (BIO SCI 199) including successful completion of BIO SCI H195 and the Excellence in Biological Sciences Research program.

**Graduation with Honors**

Of the graduating seniors, no more than 12 percent will receive Latin honors: approximately 1 percent *summa cum laude*, 3 percent *magna cum laude*, and 8 percent *cum laude*. The selection for these awards is based on spring quarter rank-ordered grade point averages. To be eligible for honors at graduation, the student must, by the end of spring quarter of the senior year, be officially declared a Biological Sciences major; submit an Application to Graduate by the end of winter quarter of the senior year; have completed at least 72 units in residence at a UC campus by the end of the spring quarter of the academic year in which they graduate; have all corrections to the academic record processed by the Registrar’s Office; and be able to verify completion of all course work by the end of the spring quarter of the senior year. Other important factors are considered at Honors Recognition.

**Excellence in Research Program**

The Francisco J. Ayala School of Biological Sciences believes that successful participation in creative research is one of the highest academic goals its undergraduates can attain. Students enrolled in Undergraduate Research (BIO SCI 199) and who meet the eligibility requirements have an opportunity to present the results of their research endeavors to peers and faculty. Those students awarded with “Excellence in Research” will then have their papers published in the School’s online *Journal of Undergraduate Research in the Biological Sciences*.

The program begins each fall with a mandatory instructional workshop and continues through spring with students completing a scientific paper, poster presentation, and scientific talk. Contact the Biological Sciences Student Affairs Office, room 1011 Biological Sciences III, or visit the Excellence in Research website (https://www.bio.uci.edu/research/#s5) for additional information.
Campuswide Honors Program
The Campuswide Honors Program is available to selected high-achieving students from all academic majors from their freshman through senior years. For more information contact the Campus-wide Honors Program, 1200 Student Services II; 949-824-5461; honors@uci.edu; or visit the Campuswide Honors Program website (http://honors.uci.edu).

Dean’s Honor List. The quarterly Dean’s Honor List is composed of students who have received a 3.5 grade point average while carrying a minimum of 12 graded units.

Biological Sciences Honors, Scholarships, Prizes, and Awards
The following honors, scholarships, prizes, and awards are presented at the annual Biological Sciences Honors Convocation held in June.

Excellence in Research Award. Undergraduates who have successfully completed the requirements for this program are presented with Excellence in Research certificates.

Brian Atwood Scholarship. The Brian Atwood Scholarship is awarded to junior Biological Sciences majors who demonstrate outstanding achievement in both scholarship and service to the UCI community.

Robert H. Avnet Memorial Scholarship. The Robert H. Avnet Memorial Scholarship has been established to assist a student interested in becoming a physician. The student must be a Biological Sciences major and demonstrate financial need.

Carol Becker McGaugh Award. This award is given to a junior with outstanding research in the area of neurobiology of learning and memory.

Robert Ernst Prize for Excellence in Research in the Biological Sciences. This prize is awarded to a student for meritorious research conducted in the field of biology.

Robert Ernst Prize for Excellence in Student Research in Plant Biology. This prize is awarded to a student for meritorious research conducted in plant biology.

Kyle Farol Memorial Award. The Kyle Farol Memorial Award is presented to an outstanding undergraduate Biological Sciences major who has dedicated their time as a volunteer in a clinical setting.

M. Marlene Godoy Award. This award is given to support a graduating senior in the Biological Sciences who is pre-medical or pre-dental. The recipient is one who is actively involved with philanthropic community service, University service, and in undergraduate research.

Dr. William F. Holcomb Scholarship. The intent of the Dr. William F. Holcomb Scholarship is to support biomedical or marine biological studies. The Scholarship is to be used to support continuing academic work over a specific period.

Laurence J. Mehlman Prize. The Laurence J. Mehlman Prize is awarded to an undergraduate student in the Francisco J. Ayala School of Biological Sciences who has demonstrated outstanding achievement in both scholarship and service to the School.

Edward Mittelman Memorial Fund Scholarship. The Edward Mittelman Memorial Fund Scholarship is presented to an outstanding Biological Sciences student who will pursue a career in the medical field.

Edward A. Steinhaus Memorial Award. The Edward A. Steinhaus Memorial Award is given to outstanding Biological Sciences graduate student teaching assistants who demonstrate promise as future educators.

Joseph H. Stephens Award for Outstanding Research in Ecology and Conservation. This award is granted to a graduate student who has demonstrated outstanding research in ecology and conservation.

Joseph H. Stephens Award for Outstanding Research in Biochemistry and Molecular Biology. This award is granted to a graduate student who has demonstrated outstanding research in biochemistry and molecular biology.

Jayne Unzelman Scholarship. The Jayne Unzelman Scholarship is presented to an undergraduate student who has shown academic excellence and been of service to the Francisco J. Ayala School of Biological Sciences and/or the University, and to the community.

Special Programs and Courses
Biological Sciences 199
The (BIO SCI 199) Undergraduate Research Training Program provides students the opportunity to pursue independent research. Students conduct experimental laboratory, field, or clinical research as an apprentice scientist under the supervision of a professor in the Francisco J. Ayala School of Biological Sciences or the School of Medicine. BIO SCI 199 research students experience the challenge and excitement of the world of science. Students develop new scientific skills and knowledge while training with professors who are on the cutting edge of research and discovery in the biological and medical sciences. The research training may commence as early as the sophomore year or, in the case of exceptional students, in the freshman year.
To participate in this unique research training program, students must be in good academic standing, and completion of both BIO SCI 94 From Organisms to Ecosystems and BIO SCI 194S Safety and Ethics for Research are mandatory prior to enrollment. Students are encouraged to investigate the possibilities for research early to assure that all requirements and deadlines are met. It is recommended that students contact a faculty sponsor at least one quarter in advance for (BIO SCI 199) enrollment. Once a faculty sponsor is acquired, the student must submit the enrollment packet to the Biological Sciences Student Affairs Office, 1011 Biological Sciences III. At the end of each quarter a Summary Report is required.

Students cannot participate in research involving human blood, body fluids, or tissue, unless special approval is granted. The faculty sponsor must submit a request for exception to the Biological Sciences Student Affairs Office.

Students conducting research directly with patients or other human subjects must comply with special enrollment procedures and the additional safety training required at the clinical site. The (BIO SCI 199) Undergraduate Research Training Program standards, procedures, enrollment packets, and announcements are available at the Biological Sciences Undergraduate Research website (https://www.bio.uci.edu/research).

The (BIO SCI 199) Undergraduate Research Training Program can provide experience that is beneficial for the future pursuit of graduate school. Information regarding research careers in the biological sciences is best obtained from a faculty research mentor.

Students should be aware that for any one quarter, a maximum of five units of independent study courses (BIO SCI 197, BIO SCI 198 or BIO SCI 199) may be taken within the Francisco J. Ayala School of Biological Sciences.

Minority Sciences Programs in Biological Sciences
The Minority Sciences Programs (MSP) in Biological Sciences is a UCI umbrella program that provides infrastructure and orchestration for the operation of minority research training grants supported by the National Institutes of Health (NIH) and other agencies. MSP seeks to increase the number of U.S. underrepresented groups in biomedical research careers. MSP participants benefit from early exposure, continuous research training, and faculty mentoring. Support is also provided through paid summer and year-round research internships, early research exposure, tutoring, academic advising, scientific writing, and participation at national conferences. Furthermore, MSP has established a campuswide, regional, national, and international network of committed faculty and resource programs to facilitate the transition from high school through community college, baccalaureate, and master’s degrees to Ph.D. careers in biomedical research and related fields. Additional information is available from the MSP office, 1104 Biological Sciences III; 949-824-2589; or visit the Minority Sciences website (http://port.bio.uci.edu).

Biological Sciences Tutoring Program
The Tutoring Program provides free tutoring for most Biological Sciences courses and is available to all students in any major. Weekly small group tutoring sessions, reviews for midterms and finals, and a growing online database of worksheets and review materials are provided. In the Tutoring Program, UCI students tutor other UCI students. For the student tutor, this program provides opportunities to develop their teaching abilities, to meet and interact with faculty, and to perform a worthwhile and necessary service. Tutors also receive academic credit. For more information, contact the Biological Sciences Student Affairs Office in 1011 Biological Sciences III or visit the Bio Sci Peer Tutoring website (https://sites.google.com/a/uci.edu/biostutor).

UC Education Abroad Program
Upper-division students have the opportunity to experience a different culture while making progress toward degree objectives through the University’s Education Abroad Program (UCEAP). UCEAP is an overseas study program which operates in cooperation with host universities and colleges throughout the world. Specifically, Biology majors should consider the UCEAP programs in the United Kingdom, Canada, Sweden, Australia, Denmark, and Costa Rica. Visit the Study Abroad Center website (http://www.studyabroad.uci.edu) for additional information.

Students may wish to participate in the UCEAP Tropical Biology Quarter which is for undergraduates with at least one year of introductory biology, one quarter of upper-division biology, and a serious interest in biological studies. The program includes lectures, field laboratories, and independent research, with an emphasis on direct field experience. Students also take a course in Spanish language and Latin American culture.

Master of Science with a Concentration in Biotechnology
The Francisco J. Ayala School of Biological Sciences offers a master’s program with a concentration in Biotechnology designed to train students to enter the field of biotechnology as skilled laboratory practitioners. The upper-division course requirements for admission into the program are extensive. Students interested in applying for admission to the Biotechnology program should plan to complete the necessary courses during their junior and senior years. Click on the Graduate tab above for more information.

Special Research Resources
Special research resources include the Beckman Laser Institute and Medical Clinic, a research, training, and service facility in the area of laser microbeam technology; the School of Biological Sciences Biohazard (P-3) Facility, which provides laboratory facilities for working with biological agents or biological molecules such as recombinant DNA which would be hazardous when used in open laboratories; the Developmental Biology Center, devoted to analyzing the cellular and genetic mechanisms underlying growth, development, and regeneration; the Center for the Neurobiology of Learning and Memory, a research center for studies of the brain mechanisms underlying learning and memory; the Institute for Memory Impairments and Neurological Disorders; the Center for Virus Research, which includes the Viral Vector Design research group; the Conservation Biology Project; the Cancer Research Institute; the Center for Immunology; the Macromolecular Structure Research Unit; the UCI Arboretum, a botanical garden facility; the San Joaquin Marsh Reserve, which supports controlled marsh biota; the Burns Piñon Ridge Reserve, a high-desert habitat in San Bernardino County; and the UCI Ecological Preserve, which includes coastal hills on the campus, once under heavy grazing, but now returning to a more natural state. It is
important to note that the Francisco J. Ayala School of Biological Sciences collaborates with the School of Medicine, thereby providing an opportunity for the sharing of both teaching and research activities. These collaborative efforts include the Institute for Genomics and Bioinformatics; the Reeve-Irvine Research Center; and the Bio-Imaging Interest Group.

**Advising: Academic, Career, Health Sciences**

1011 Biological Sciences III
http://www.bio.uci.edu/students/undergraduates/contact-us/

**Academic Advising**

The Biological Sciences Student Affairs Office coordinates the advising program and provides academic counseling as well as special services particularly in the area of preprofessional career counseling. Undergraduate Biological Sciences students should consult the Biological Sciences Student Affairs Office for information on academic requirements for the degree, career opportunities, the BIO SCI 199 Research Program, available tutoring for Biological Sciences courses, Biological Sciences student organizations, and scholarship information. Students can also come to the Biological Sciences Student Affairs Office to change their major, apply for graduation, or for any other help they might need related to their academic career at UCI.

**Peer Academic Advisors.** The Peer Academic Advisors are upper-division Biological Sciences majors who bring with them valuable academic and social experiences. Their functions include counseling students in matters of major selection, program planning, petitioning, tutoring, learning skills problems, and participation in co-curricular and extracurricular activities.

The Peer Advisors are located in the Biological Sciences Student Affairs Office. Office hours are posted at the beginning of each quarter.

**Career Advising**

Information on graduate and professional schools in the health sciences can be obtained from the Biological Sciences Student Affairs Office. The UCI Career Center provides services to students and alumni including career counseling, information about job opportunities, a career library, and workshops on resume preparation, job search, and interview techniques. See the Career Center section for additional information.

Areas of opportunity open to those with a Bachelor of Science degree include laboratory technology, publishing, technical editing, pharmaceutical sales, and training programs in county, state, and federal agencies. The bachelor’s degree is necessary to pursue studies leading to the M.S. and Ph.D. degrees.

The B.S. degree, plus short training periods, may prepare students for employment in education, medical technology (usually one year), allied health positions, and various other areas.

Education (community colleges, state colleges, or private schools), medical illustration, and public health (which includes hospital administration, biostatistics, epidemiology, environmental health sciences, social work, public health education, maternal and child health, and infectious and tropical diseases) are fields in which opportunities are available upon completion of a master’s program.

The Ph.D. degree may lead to research in many areas, among them biochemistry, biometeorology, botany, cytology, ecology, fishery biology, genetics, home economics, microbiology, molecular biology, pathology, physiology, psychobiology, public health, range management, soil conservation, and zoology.

Other areas where advanced degrees are necessary include medicine, dentistry, law, optometry, podiatry, osteopathy, physical therapy, and veterinary medicine.

**Health Sciences Advising**

Advising for careers in the health sciences is a specialty of the Biological Sciences Student Affairs Office. Students desiring to enter the health sciences should have their programs checked in the Office and should plan to enroll in BIO SCI 3A. Admissions tests for medical, dental, pharmacy, and graduate schools should be taken in the spring, a year and one-half before the student plans to enter.

Leaders in nearly all health professional schools recommend that students preparing to seek admission to their schools plan to obtain a bachelor’s degree. Students who plan to enter a school of dentistry, medicine, or other areas of the health sciences may receive the required preprofessional training at UCI. This preprofessional training may be accomplished by (1) completing the major in Biological Sciences or (2) majoring in any school or department and fulfilling concurrently the specific course requirements of the dental, medical, or other professional school the student expects to attend.

Students interested in the health sciences should choose electives in the social sciences, possibly a foreign language, physical chemistry, or other specific courses required or recommended by graduate schools.

**Student Participation**

A wide variety of student associations, clubs, and groups provide opportunities for Francisco J. Ayala School of Biological Sciences students to participate in different types of activities and events. The groups are wide ranging and include nationally recognized honors societies such as Alpha Epsilon Delta, volunteer service organizations such as the Flying Sams, specialized groups such as the UCI Sports Medicine Club, and more. Detailed information about the numerous options is available at Biological Sciences Undergraduate Careers and Student Organizations website (https://www.bio.uci.edu/undergraduates/careers).
Requirements for the Bachelor's Degree

All School of Biological Sciences students must complete the following requirements.

All students must meet the University Requirements.
All students must meet the School Requirements, as shown below:

Complete:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tr>
<td>BIO SCI 2A</td>
<td>Freshman Seminar</td>
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<tr>
<td>BIO SCI 194S</td>
<td>Safety and Ethics for Research</td>
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Biological Sciences Core:

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<th>Course Title</th>
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<tr>
<td>BIO SCI 93</td>
<td>From DNA to Organisms</td>
</tr>
<tr>
<td>BIO SCI 94</td>
<td>From Organisms to Ecosystems</td>
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<td>BIO SCI 97</td>
<td>Genetics</td>
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<td>BIO SCI 98</td>
<td>Biochemistry</td>
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<td>BIO SCI 99</td>
<td>Molecular Biology</td>
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<tr>
<td>BIO SCI 100</td>
<td>Scientific Writing</td>
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</table>

Select one of the following General Chemistry sequences:

- CHEM 1A- 1B- 1C General Chemistry and General Chemistry
- CHEM 1LC- 1LD General Chemistry Laboratory and General Chemistry Laboratory
- CHEM H2A- H2B- H2C Honors General Chemistry and Honors General Chemistry
- CHEM H2LA- H2LB- H2LC Honors General Chemistry Laboratory and Honors General Chemistry Laboratory

Select one of the following Organic Chemistry sequences:

- CHEM 51A- 51B- 51C Organic Chemistry and Organic Chemistry
- CHEM 51LB- 51LC Organic Chemistry Laboratory and Organic Chemistry Laboratory
- CHEM H52A- H52B- H52C Honors Organic Chemistry and Honors Organic Chemistry
- CHEM H52LA- H52LB Honors Organic Chemistry Laboratory and Honors Organic Chemistry Laboratory

Complete:

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<tbody>
<tr>
<td>MATH 2A- 2B</td>
<td>Single-Variable Calculus</td>
</tr>
</tbody>
</table>

Select one of the following:

- STATS 7 Basic Statistics
- STATS 8 Introduction to Biological Statistics
- MATH 2D Multivariable Calculus
- MATH 3A Introduction to Linear Algebra

Select one of the following Physics Series:

Series A
Prerequisites for all Biological Sciences Core courses are rigorously enforced. Students must have a 2.0 cumulative grade point average in the Biological Sciences Core Curriculum, four upper-division elective courses, and three upper-division laboratories.

**Upper-Division Writing Requirement**

Students in the Francisco J. Ayala School of Biological Sciences have the option to satisfy the upper-division writing requirement by completing BIO SCI 100 with a grade of Pass, followed by the completion of three upper-division laboratories selected from the following:

- BIO SCI D111L: Developmental and Cell Biology Laboratory
- BIO SCI E106L: Habitats and Organisms
- BIO SCI E112L: Physiology Laboratory
- BIO SCI E115L: Evolution Laboratory
- BIO SCI E131L: Image Analysis in Biological Research
- BIO SCI E161L: Biology of Birds Lab
- BIO SCI E172L: Plant Systematics Laboratory
- BIO SCI E179L: Field Freshwater Ecology
- BIO SCI M114L: Biochemistry Laboratory
- BIO SCI M116L: Molecular Biology Laboratory
- BIO SCI M118L: Experimental Microbiology Laboratory
- BIO SCI M121L: Advanced Immunology Laboratory
- BIO SCI M122L: Advanced Microbiology Laboratory
- BIO SCI M124L: Virus Engineering Laboratory
- BIO SCI M127L: Virology and Immunology Laboratory
- BIO SCI M130L: Advanced Molecular Lab Techniques
- BIO SCI N113L: Neurobiology Laboratory

Students must earn a grade of C or better in each of the three laboratories selected. Completion of the Excellence in Research in Biological Sciences program may count as one of the three-upper division labs.

**School Residence Requirement**

After matriculation, all courses required for the major must be successfully completed at UCI. Students must be a major in the Francisco J. Ayala School of Biological Sciences for the 3 academic quarters (excluding summer session) immediately preceding degree certification. The Francisco J. Ayala School of Biological Sciences strictly enforces the UCI residence requirement. At least 36 of the final 45 units completed by a student for the bachelor’s degree must be earned in residence at the UCI campus. (The School considers courses taken in the UC Education Abroad Program to be in-residence courses.)

**Undergraduate Programs**

The following majors are offered:

- Biological Sciences
- Biology/Education
- Biochemistry and Molecular Biology
- Developmental and Cell Biology
- Ecology and Evolutionary Biology
- Exercise Sciences
- Genetics
- Human Biology
- Microbiology and Immunology
• Neurobiology

Admission to the Major in Biological Sciences

In the event that the number of students who elect Biological Sciences as a major exceeds the number of positions available, applicants may be subject to screening beyond minimum University of California admissions requirements.

Freshmen: Preference will be given to those who rank the highest using the selection criteria as stated in the Undergraduate Admissions section of this Catalogue.

Transfer students: Junior-level applicants with the highest grades overall and who satisfactorily complete course prerequisites will be given preference for admission. All applicants must complete one year of general chemistry with laboratory with grades of C or better; one year of organic chemistry with laboratory with grades of C or better; one year of biology courses equivalent to BIO SCI 93, BIO SCI 94 at UCI with a grade of C or better in each course; and have a cumulative GPA of 3.0 or higher.

No student may enter as a double major, but Biological Sciences students interested in other areas may apply to become double majors after the first quarter, if the second school or program approves. A strong academic performance in the second area is requisite for acceptance as a double major.

Change of Major

Students who wish to declare any major within the Francisco J. Ayala School of Biological Sciences should contact the Biological Sciences Student Affairs Office in 1011 Biological Sciences III for information about change-of-major requirements, procedures, and policies. Information can also be found at UC Irvine Change of Major Criteria website (http://www.changeofmajor.uci.edu). Change of Major requests are accepted and reviewed by the School throughout the year.

Undergraduate Major in Biological Sciences

The Biological Sciences major presents a unified, in-depth study of modern biology. The Biological Sciences Core is a five-quarter series of courses ranging from ecology and evolutionary biology, to genetics, biochemistry, and molecular biology. Important laboratory techniques and methodology are presented in upper-division laboratories. Advanced elective courses provide an opportunity to continue to diversify students’ exposure to the biological sciences or to gain a much more in-depth study of a particular area of the biological sciences.

NOTE: Biological Sciences majors who successfully complete their second year of study may elect to apply for a change of major to one of the following: Biochemistry and Molecular Biology, Developmental and Cell Biology, Genetics, Microbiology and Immunology, or Neurobiology. Students may apply directly to the Biology/Education major or the Ecology and Evolutionary Biology major when they apply for admission to UCI. Contact the Biological Sciences Student Affairs Office for more information.

Requirements for the B.S. Degree in Biological Sciences

All students must meet the University Requirements.
All students must meet the School Requirements.

Major Requirements

A. Required Major Courses:

Select three of the following:

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<thead>
<tr>
<th>Course</th>
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<td>Cell Biology</td>
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<td>BIO SCI D104</td>
<td>Developmental Biology</td>
</tr>
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<td>BIO SCI D105</td>
<td>Cell, Developmental, and Molecular Biology of Plants</td>
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<tr>
<td>BIO SCI E106</td>
<td>Processes in Ecology and Evolution</td>
</tr>
<tr>
<td>BIO SCI E109</td>
<td>Human Physiology</td>
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<tr>
<td>BIO SCI N110</td>
<td>Neurobiology and Behavior</td>
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</table>

B. Upper-Division Laboratories:

Select three of the following:

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<th>Course</th>
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<tbody>
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<td>BIO SCI D111L</td>
<td>Developmental and Cell Biology Laboratory</td>
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<tr>
<td>BIO SCI E106L</td>
<td>Habitats and Organisms</td>
</tr>
<tr>
<td>BIO SCI E112L</td>
<td>Physiology Laboratory</td>
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<tr>
<td>BIO SCI E115L</td>
<td>Evolution Laboratory</td>
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</tbody>
</table>
BIO SCI M116L  Molecular Biology Laboratory
BIO SCI M118L  Experimental Microbiology Laboratory
BIO SCI M121L  Advanced Immunology Laboratory
BIO SCI M122L  Advanced Microbiology Laboratory
BIO SCI M124L  Virus Engineering Laboratory
BIO SCI M127L  Virology and Immunology Laboratory
BIO SCI M130L  Advanced Molecular Lab Techniques
BIO SCI N113L  Neurobiology Laboratory

One laboratory can be satisfied with completion of Excellence in Research in the Biological Sciences.

C. Upper-Division Biology Electives:
Select four upper-division, four-unit courses from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI D103–D190, E106–E190, M114–M190, N110–N190</td>
<td>Molecular Pharmacology I</td>
</tr>
<tr>
<td>PHRMSCI 170A</td>
<td>Molecular Pharmacology II</td>
</tr>
<tr>
<td>PHRMSCI 171</td>
<td>Physical Biochemistry</td>
</tr>
<tr>
<td>PHRMSCI 173</td>
<td>Pharmacotherapy</td>
</tr>
<tr>
<td>PHRMSCI 174</td>
<td>Biopharmaceutics and Nanomedicine</td>
</tr>
<tr>
<td>PHRMSCI 177</td>
<td>Medicinal Chemistry</td>
</tr>
</tbody>
</table>

The following courses can be used to partially satisfy the Upper-Division Biology Elective Requirement:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 131A-131B-131C</td>
<td>Quantum Principles and Molecular Structure and Elementary Statistical Mechanics and Thermodynamics and Chemical Dynamics</td>
</tr>
<tr>
<td>PHYSICS 147A-147B</td>
<td>Principles of Imaging and Techniques in Medical Imaging I: X-ray, Nuclear, and NMR Imaging</td>
</tr>
</tbody>
</table>

Additionally, Psychology/Biological Sciences double majors may also use PSYCH 112A-PSYCH 112B-PSYCH 112C to partially satisfy the Upper-Division Biology Elective Requirement.

NOTE: Double majors within the School of Biological Sciences or with Public Health Sciences, Biomedical Engineering: Premedical, Nursing Science, or Pharmaceutical Sciences are not permitted.

1 BIO SCI D103, BIO SCI D104, BIO SCI D105, BIO SCI E106, BIO SCI E109, BIO SCI N110 may not be used to satisfy more than one requirement.

Concentration in Biological Sciences Education

The optional concentration in Biological Sciences Education requires eight courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI 14</td>
<td>California Teach 1: Introduction to Science and Mathematics Teaching</td>
</tr>
<tr>
<td>BIO SCI 101</td>
<td>California Teach 2: Middle School Science and Mathematics Teaching</td>
</tr>
<tr>
<td>BIO SCI 102</td>
<td>California Teach 3: High School Science and Mathematics Teaching</td>
</tr>
<tr>
<td>EARTHSS 1</td>
<td>Introduction to Earth System Science</td>
</tr>
<tr>
<td>EARTHSS 7</td>
<td>Physical Geology</td>
</tr>
<tr>
<td>PHYSICS 20A</td>
<td>Introduction to Astronomy</td>
</tr>
<tr>
<td>PHYSICS 20B</td>
<td>Cosmology: Humanity’s Place in the Universe</td>
</tr>
</tbody>
</table>

Select one of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDUC 108</td>
<td>Adolescent Development and Education</td>
</tr>
<tr>
<td>EDUC 124</td>
<td>Multicultural Education in K-12 Schools</td>
</tr>
<tr>
<td>EDUC 128</td>
<td>Exceptional Learners</td>
</tr>
<tr>
<td>EDUC 131</td>
<td>Educational Technology</td>
</tr>
<tr>
<td>EDUC 173</td>
<td>Cognition and Learning in Educational Settings</td>
</tr>
</tbody>
</table>

The requirements for a general Biological Sciences B.S. degree for students in this concentration will be reduced by one upper-division laboratory course (major requirement B) and two upper-division biology electives (major requirement C). Students pursuing other majors within the Francisco J. Ayala School of Biological Sciences will need specific departmental approval for the reduction of degree requirements when completing this concentration.
Planning a Program of Study

Since biological sciences courses are built upon a base of the physical sciences, it is very important for students to take their required physical sciences early, particularly general and organic chemistry. Students who have not completed high school chemistry are well advised to complete a preparatory chemistry course before entering UCI. The academic program shown below is only a suggested program. Students should consult the Biological Sciences Student Affairs Office for individual academic planning.

Freshmen will normally take HUMAN 1A and HUMAN 1AS or lower-division writing courses, CHEM 1A, BIO SCI 93, and a freshman seminar (BIO SCI 2A) during the fall quarter. Students will then continue with BIO SCI 94, complete their general chemistry requirement, and continue with Humanities or lower-division writing during the remaining winter and spring quarters.

Sophomores begin organic chemistry (CHEM 51A or CHEM H52A) and continue the Biological Sciences Core with BIO SCI 97, BIO SCI 93, BIO SCI 94. Sophomores often begin taking courses in other disciplines to meet the UCI general education requirement and fulfill their mathematics requirement if they have not done so as freshmen.

During their junior year, most majors continue with the Biological Sciences electives and take physics. Students who intend to double major in Chemistry will be required to take PHYSICS 7C-PHYSICS 7D-PHYSICS 7E in place of PHYSICS 3A-PHYSICS 3B-PHYSICS 3C. Juniors may complete their general education requirements and usually start their research and their upper-division biology laboratory courses.

Finally, during their senior year, students continue their research and complete their remaining major requirements.

Students in the Biological Sciences major are required to make progress toward their degree, and their progress will be monitored. If normal academic progress toward the degree in Biological Sciences is not being met, students will be subject to probation.

Sample Program — Biological Sciences

<table>
<thead>
<tr>
<th>Freshman</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIO SCI 93</td>
<td>BIO SCI 94</td>
<td>CHEM 1C - 1LC</td>
</tr>
<tr>
<td>CHEM 1A</td>
<td>CHEM 1B</td>
<td>HUMAN 1C</td>
</tr>
<tr>
<td>HUMAN 1A\textsuperscript{1}</td>
<td>HUMAN 1B</td>
<td>HUMAN 1CS</td>
</tr>
<tr>
<td>HUMAN 1AS\textsuperscript{1}</td>
<td>HUMAN 1BS</td>
<td>MATH 2A</td>
</tr>
<tr>
<td>BIO SCI 2A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sophomore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIO SCI 97</td>
<td>BIO SCI 98</td>
<td>CHEM 1LD</td>
</tr>
<tr>
<td>CHEM 51A\textsuperscript{2}</td>
<td>CHEM 51B - 51LB</td>
<td>Gen. Ed.</td>
</tr>
<tr>
<td>CHEM 1LD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MATH 2B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIO SCI 194S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required Major course</td>
<td>Required Major course</td>
<td>Required Major course</td>
</tr>
<tr>
<td>Physics</td>
<td>Physics</td>
<td>Physics</td>
</tr>
<tr>
<td>Elective/Research</td>
<td>Elective/Research</td>
<td>Bio. Sci. elective</td>
</tr>
<tr>
<td>BIO SCI 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
<td>Electives</td>
</tr>
</tbody>
</table>

\textsuperscript{1} Students have the option of taking HUMAN 1A and HUMAN 1AS or lower-division writing courses.
\textsuperscript{2} CHEM H52A-CHEM H52B-CHEM H52C, CHEM H52A-CHEM H52LB may be taken instead of CHEM 51A-CHEM 51B-CHEM 51C, CHEM 51LB-CHEM 51LC.

Undergraduate Major in Biology/Education

Earning a Bachelor’s Degree in Biology with a Teaching Credential

Biological Sciences students who are interested in pursuing a teaching career should consider the UCI Cal Teach Science and Mathematics Program. This program offers Biology/Education majors the opportunity to earn their bachelor’s degree concurrently with a California Preliminary Single Subject Teaching Credential. Individuals who hold this credential are authorized to teach biology and general science in a middle school or high school.
Students complete the degree requirements for this major, which include:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI 14</td>
<td>California Teach 1: Introduction to Science and Mathematics Teaching</td>
</tr>
<tr>
<td>BIO SCI 101</td>
<td>California Teach 2: Middle School Science and Mathematics Teaching</td>
</tr>
<tr>
<td>BIO SCI 108</td>
<td>Research Methods</td>
</tr>
<tr>
<td>EDUC 55</td>
<td>Knowing and Learning in Mathematics and Science</td>
</tr>
<tr>
<td>EDUC 109</td>
<td>Reading and Writing in Secondary Mathematics and Science Classrooms</td>
</tr>
<tr>
<td>EDUC 143AW</td>
<td>Classroom Interactions I</td>
</tr>
<tr>
<td>EDUC 143BW</td>
<td>Classroom Interactions II</td>
</tr>
<tr>
<td>EDUC 148</td>
<td>Complex Pedagogical Design</td>
</tr>
<tr>
<td>EDUC 158</td>
<td>Student Teaching Mathematics and Science in Middle/High School (two quarters)</td>
</tr>
<tr>
<td>LPS 60</td>
<td>The Making of Modern Science</td>
</tr>
</tbody>
</table>

Beyond course work, some additional requirements for teacher certification are described below. With careful, early planning, it is possible for students to complete their bachelor’s degree and teacher certification in four years. This is a more time-efficient and cost-effective route than the traditional five-year teacher preparation model, which usually involves a full academic year of teacher education courses and clinical teaching experience after completion of a bachelor’s degree.

After the Francisco J. Ayala School of Biological Sciences verifies the completion of all requirements for the bachelor’s degree, students are awarded their degree from UC Irvine. By contrast, the Preliminary Single Subject Teaching Credential is awarded by the California Commission on Teacher Credentialing (CTC) upon completion of a bachelor’s degree and the state-approved UCI teacher education program, which combines course work, student teaching, and a teaching performance assessment. The UCI School of Education must verify completion of all requirements for the teaching credential and then recommend that the credential be awarded to a candidate by the CTC.

**Additional Requirements for Teacher Certification.** In addition to the required course work for a California Preliminary Single Subject Teaching Credential, some additional requirements must be satisfied:

1. The Francisco J. Ayala School of Biological Sciences requires a *cumulative* GPA of 2.0 (C) to graduate with the bachelor’s degree.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI 101</td>
<td>California Teach 2: Middle School Science and Mathematics Teaching</td>
</tr>
<tr>
<td>EDUC 55</td>
<td>Knowing and Learning in Mathematics and Science</td>
</tr>
<tr>
<td>EDUC 109</td>
<td>Reading and Writing in Secondary Mathematics and Science Classrooms</td>
</tr>
<tr>
<td>EDUC 143AW</td>
<td>Classroom Interactions I</td>
</tr>
<tr>
<td>EDUC 143BW</td>
<td>Classroom Interactions II</td>
</tr>
<tr>
<td>EDUC 148</td>
<td>Complex Pedagogical Design</td>
</tr>
<tr>
<td>EDUC 158</td>
<td>Student Teaching Mathematics and Science in Middle/High School</td>
</tr>
</tbody>
</table>

   a. However, students must earn a grade of *C or better* in the following courses in order to be recommended for the Preliminary Single Subject Credential:

   b. In the final phase of teaching preparation, students enrolled in EDUC 158 gain teaching experience as a “student teacher” at a local middle school or high school, while also attending a weekly student teaching seminar at UCI. Each student teacher is paired with a highly qualified science teacher who acts as a mentor while the student teacher gradually takes on full responsibility for daily lesson planning, instruction, and assessment. Cal Teach program instructors select the mentor teachers and match them with student teachers. During the winter and spring quarters when students are enrolled in EDUC 158, they should expect to spend a minimum of four hours per day (typically mornings), five days per week, in their student teaching assignment at a middle school or high school.

2. The following must be completed and verified prior to the start of student teaching in EDUC 158:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARTHSS 1</td>
<td>Introduction to Earth System Science</td>
</tr>
<tr>
<td>EARTHSS 7</td>
<td>Physical Geology</td>
</tr>
<tr>
<td>PHYSICS 20A</td>
<td>Introduction to Astronomy</td>
</tr>
<tr>
<td>BIO SCI 101</td>
<td>California Teach 2: Middle School Science and Mathematics Teaching</td>
</tr>
<tr>
<td>EDUC 143AW</td>
<td>Classroom Interactions I</td>
</tr>
<tr>
<td>EDUC 148</td>
<td>Complex Pedagogical Design</td>
</tr>
</tbody>
</table>

   a. Pass the California Basic Education Skills Test (CBEST), a basic mathematics and literacy skills test. For more information, see http://www.ctcexams.nesinc.com/test_info_CBEST.asp.

   b. Pass the California Subject Exam for Teachers (CSET) in science: biology/life science. Although secondary teachers are only required to pass the CSET exam in one discipline, those who pass the CSET exam in more than one disciplinary field (e.g. biology/life science

   or mathematics) are prepared to teach in either discipline. For more information on the CSET, visit http://www.ctcexams.nesinc.com/test_info_CSET.asp.
and chemistry) can be authorized to teach classes in each of those disciplines. For more information about the CSET exam, see http://www.ctcexams.nesinc.com/tests.asp.

c. Secondary school science teachers in California are expected to have a broad range of general science knowledge in addition to their discipline of specialization, because their Single Subject Teaching Credential in one of the sciences also authorizes them to teach classes in general or integrated science. The general science subtests of the CSET exam cover foundational topics in astronomy, geodynamics, Earth resources, ecology, genetics and evolution, molecular biology and biochemistry, cellular and organismal biology, waves, forces and motion, electricity and magnetism, heat transfer and thermodynamics, and structure and properties of matter. Although students can prepare for the CSET exam's general science subtests through independent study, Biological Sciences students can also prepare by taking lower-division courses that cover the content. Here are some suggested courses for Biology/Education majors:

d. Obtain a Certificate of Clearance from the State of California.

e. Obtain a TB test with negative results.

f. Demonstrate readiness for student teaching responsibilities as evidenced in course work and satisfactory observations of a candidate during field experiences.

3. The following must be completed and verified before the School of Education is able to recommend an individual for the Preliminary Single Subject Credential:

a. Pass a state-approved teacher performance assessment, which is completed concurrently with student teaching in EDUC 158.

b. Complete a college-level course or pass an examination on the U.S. Constitution. POL SCI 21A satisfies this requirement. Contact the UCI School of Education Student Affairs Office for information about the exam.

c. Obtain a CPR certificate in adult, child, or infant training.

Declaring Intention to Complete the Biology/Education Major and Teacher Certification. Prospective teachers who want to complete their degree and a teaching credential in four years are encouraged to start planning early by reviewing the sample program for the Biology/Education major, and consulting with an academic counselor. Interested students are encouraged to get started on the suggested first- and second-year credentialing course work, including BIO SCI 14 and BIO SCI 101, and can do so without officially declaring their intention to complete the credential. However, students must declare their intention to complete requirements for the Biology/Education major and requirements for the Preliminary Single Subject Teaching Credential prior to enrolling in EDUC 55, which they would typically take in fall of their third year. Forms for declaring an intention to complete the teaching credential are available in the Biological Sciences Student Affairs Office or in the Cal Teach Science and Mathematics Resource and Advising Center (137 Biological Sciences Administration).

Requirements for the B.S. Degree in Biology/Education
All students must meet the University Requirements.
All students must meet the School Requirements.
School requirement variation: BIO SCI 100, CHEM 51C, and CHEM 51LC are not required of Biology/Education majors.

Major Requirements

A. Required Major Courses:

Select three of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI D103</td>
<td>Cell Biology</td>
</tr>
<tr>
<td>BIO SCI D104</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>BIO SCI D105</td>
<td>Cell, Developmental, and Molecular Biology of Plants</td>
</tr>
<tr>
<td>BIO SCI E106</td>
<td>Processes in Ecology and Evolution</td>
</tr>
<tr>
<td>BIO SCI E109</td>
<td>Human Physiology</td>
</tr>
<tr>
<td>BIO SCI N110</td>
<td>Neurobiology and Behavior</td>
</tr>
</tbody>
</table>

B. Upper-Division Laboratories:

Select two of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI D111L</td>
<td>Developmental and Cell Biology Laboratory</td>
</tr>
<tr>
<td>BIO SCI E106L</td>
<td>Habitats and Organisms</td>
</tr>
<tr>
<td>BIO SCI E112L</td>
<td>Physiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI E115L</td>
<td>Evolution Laboratory</td>
</tr>
<tr>
<td>BIO SCI E131L</td>
<td>Image Analysis in Biological Research</td>
</tr>
<tr>
<td>BIO SCI E161L</td>
<td>Biology of Birds Lab</td>
</tr>
<tr>
<td>BIO SCI E166L</td>
<td>Field Biology</td>
</tr>
<tr>
<td>BIO SCI E172L</td>
<td>Plant Systematics Laboratory</td>
</tr>
<tr>
<td>BIO SCI E179L</td>
<td>Field Freshwater Ecology</td>
</tr>
<tr>
<td>BIO SCI M114L</td>
<td>Biochemistry Laboratory</td>
</tr>
<tr>
<td>BIO SCI M116L</td>
<td>Molecular Biology Laboratory</td>
</tr>
</tbody>
</table>
BIO SCI M118L  Experimental Microbiology Laboratory
BIO SCI M121L  Advanced Immunology Laboratory
BIO SCI M122L  Advanced Microbiology Laboratory
BIO SCI M124L  Virus Engineering Laboratory
BIO SCI M127L  Virology and Immunology Laboratory
BIO SCI M130L  Advanced Molecular Lab Techniques
BIO SCI N113L  Neurobiology Laboratory

One laboratory can be satisfied with completion of Excellence in Research in the Biological Sciences.

C. Upper-Division Biology Electives:
Select two, four-unit courses from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI D103–D190, E106–E190, M114–M190, N110–N190</td>
<td>Molecular Pharmacology I</td>
</tr>
<tr>
<td>PHRMSCI 170A</td>
<td>Molecular Pharmacology II</td>
</tr>
<tr>
<td>PHRMSCI 170B</td>
<td>Physical Biochemistry</td>
</tr>
<tr>
<td>PHRMSCI 171</td>
<td>Pharmacotherapy</td>
</tr>
<tr>
<td>PHRMSCI 173</td>
<td>Biopharmaceutics and Nanomedicine</td>
</tr>
<tr>
<td>CHEM 177</td>
<td>Medicinal Chemistry</td>
</tr>
</tbody>
</table>

The following courses can be used to partially satisfy the Upper-Division Biology Elective Requirement:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 131A-131B-131C</td>
<td>Quantum Principles and Molecular Structure and Elementary Statistical Mechanics and Thermodynamics and Chemical Dynamics</td>
</tr>
<tr>
<td>or</td>
<td>PHYSICS 147A-147B</td>
</tr>
</tbody>
</table>

Additionally, Psychology/Biological Sciences double majors may also use PSYCH 112A-PSYCH 112B-PSYCH 112C to partially satisfy the Upper-Division Biology Elective Requirement.

D. Science Teaching Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI 14</td>
<td>California Teach 1: Introduction to Science and Mathematics Teaching</td>
</tr>
<tr>
<td>BIO SCI 101</td>
<td>California Teach 2: Middle School Science and Mathematics Teaching</td>
</tr>
<tr>
<td>BIO SCI 108</td>
<td>Research Methods</td>
</tr>
<tr>
<td>EDUC 55</td>
<td>Knowing and Learning in Mathematics and Science</td>
</tr>
<tr>
<td>EDUC 109</td>
<td>Reading and Writing in Secondary Mathematics and Science Classrooms</td>
</tr>
<tr>
<td>EDUC 143AW</td>
<td>Classroom Interactions I</td>
</tr>
<tr>
<td>EDUC 143BW</td>
<td>Classroom Interactions II</td>
</tr>
<tr>
<td>EDUC 148</td>
<td>Complex Pedagogical Design</td>
</tr>
<tr>
<td>EDUC 158</td>
<td>Student Teaching Mathematics and Science in Middle/High School (two quarters)</td>
</tr>
<tr>
<td>LPS/HISTORY 60</td>
<td>The Making of Modern Science</td>
</tr>
</tbody>
</table>

NOTE: Double majors within the Francisco J. Ayala School of Biological Sciences or with Public Health Sciences, Biomedical Engineering: Premedical, Nursing Science, or Pharmaceutical Sciences are not permitted.

### Sample Program — Biology/Education

#### Freshman

<table>
<thead>
<tr>
<th>Term</th>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>BIO SCI 93</td>
<td>BIO SCI 94</td>
</tr>
<tr>
<td></td>
<td>CHEM 1A</td>
<td>CHEM 1B</td>
</tr>
<tr>
<td></td>
<td>WRITING 39A</td>
<td>WRITING 39B-39C</td>
</tr>
<tr>
<td></td>
<td>BIO SCI 14</td>
<td></td>
</tr>
<tr>
<td>Winter</td>
<td>BIO SCI 94</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CHEM 1B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WRITING 39B</td>
<td>WRITING 39B-39C</td>
</tr>
<tr>
<td></td>
<td>BIO SCI 14</td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>CHEM 1C-1LC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Writing/General Ed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MATH 2A</td>
<td></td>
</tr>
</tbody>
</table>

#### Sophomore

<table>
<thead>
<tr>
<th>Term</th>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>BIO SCI 97</td>
<td>BIO SCI 98</td>
</tr>
<tr>
<td></td>
<td>CHEM 51A</td>
<td>CHEM 51B-51LB</td>
</tr>
<tr>
<td>Winter</td>
<td>BIO SCI 98</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CHEM 51B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CHEM 51B-51LB</td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>BIO SCI 99</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LPS 60 or HISTORY 60</td>
<td></td>
</tr>
</tbody>
</table>

1 BIO SCI D103, BIO SCI D104, BIO SCI D105, BIO SCI E106, BIO SCI E109, BIO SCI N110 may not be used to satisfy more than one requirement.
Undergraduate Major in Biochemistry and Molecular Biology

Few areas of Biological Sciences remain that are not impacted by studies at the chemical and molecular level. The major in Biochemistry and Molecular Biology is designed to provide a comprehensive background in this modern, conceptual understanding of biology. Students who wish to begin in-depth study of the molecular basis in any of a variety of fields, including development, gene expression, immunology, pathogenesis, disease, virology, and evolution, can do so through this major. This program will be especially attractive to those students who intend to pursue an advanced degree in biological or medical sciences.

The Biochemistry and Molecular Biology major is based upon required courses in Advanced Biochemistry and Advanced Molecular Biology (BIO SCI M114 and BIO SCI M116). These courses, together with a wide variety of elective course offerings, provide majors the choice to either explore the breadth of the field or follow a more in-depth study of any of its subdisciplines. For students interested in the interface between biology and chemistry, this program articulates well with a second major in Chemistry.

The program of study emphasizes laboratory experience and its integration with basic theory. This is accomplished in three ways: first, through coordination between the advanced courses in Biochemistry (BIO SCI M114) and Molecular Biology (BIO SCI M116), and laboratory courses in Biochemistry (BIO SCI M114L) and Molecular Biology (BIO SCI M114L) which provide students with the basic laboratory skills and an appreciation for the experimental foundations of the field; second, through advanced laboratories in Immunology (BIO SCI M121L) and Virology (BIO SCI M127L) which provide students with the opportunity to develop cutting edge research skills; and third, by emphasizing independent research sponsored by a participating faculty member. The program encourages the research interests of students in subdisciplines other than immunology or virology by offering the opportunity to substitute one year of independent research for the advanced laboratory.

The major in Biochemistry and Molecular Biology is designed to provide students with the appropriate tools and training to successfully pursue graduate degrees that emphasize basic scientific research, including Ph.D. and M.S. training as well as combined M.D./Ph.D. programs. In addition, and particularly with the explosive growth in biotechnology and its significant influence in everyday life, graduates could use their backgrounds very effectively to pursue careers in business, education, law, and public affairs.

Requirements for the B.S. Degree in Biochemistry and Molecular Biology

All students must meet the University Requirements.

All students must meet the School Requirements.

Major Requirements

A. Required Major Courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>BIO SCI M114</td>
<td>Advanced Biochemistry</td>
</tr>
<tr>
<td>BIO SCI M116</td>
<td>Advanced Molecular Biology</td>
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</table>

B. Upper-Division Laboratories:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI M114L</td>
<td>Biochemistry Laboratory</td>
</tr>
<tr>
<td>BIO SCI M116L</td>
<td>Molecular Biology Laboratory</td>
</tr>
</tbody>
</table>

Select one of the following:

<table>
<thead>
<tr>
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<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Advanced Immunology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M124L</td>
<td>Virus Engineering Laboratory</td>
</tr>
<tr>
<td>BIO SCI M127L</td>
<td>Virology and Immunology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M130L</td>
<td>Advanced Molecular Lab Techniques</td>
</tr>
<tr>
<td>BIO SCI 199</td>
<td>Study in Biological Science Research (Approved by the Biochemistry and Molecular Biology Faculty Board.)</td>
</tr>
</tbody>
</table>

C. Upper-Division Biology Electives:

Select three of the following:

<table>
<thead>
<tr>
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<th>Title</th>
</tr>
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<tbody>
<tr>
<td>BIO SCI M120-M189</td>
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Select one of the following:

<table>
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<tr>
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<th>Title</th>
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<tr>
<td>BIO SCI D137</td>
<td>Eukaryotic and Human Genetics</td>
</tr>
<tr>
<td>BIO SCI D145</td>
<td>Genomics, Development, and Medicine</td>
</tr>
<tr>
<td>BIO SCI M120–M190</td>
<td></td>
</tr>
<tr>
<td>CHEM 128</td>
<td>Introduction to Chemical Biology</td>
</tr>
<tr>
<td>CHEM 131A</td>
<td>Quantum Principles</td>
</tr>
<tr>
<td>CHEM 131B</td>
<td>Molecular Structure and Elementary Statistical Mechanics</td>
</tr>
<tr>
<td>CHEM 131C</td>
<td>Thermodynamics and Chemical Dynamics</td>
</tr>
<tr>
<td>PHRMSCI 170A</td>
<td>Molecular Pharmacology I</td>
</tr>
<tr>
<td>PHRMSCI 171</td>
<td>Physical Biochemistry</td>
</tr>
</tbody>
</table>

Select two four-unit courses from the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>BIO SCI D103–D189, E106–E189, M120–M190, N110–N189</td>
<td></td>
</tr>
<tr>
<td>CHEM 128</td>
<td>Introduction to Chemical Biology</td>
</tr>
<tr>
<td>CHEM 131A</td>
<td>Quantum Principles</td>
</tr>
<tr>
<td>CHEM 131B</td>
<td>Molecular Structure and Elementary Statistical Mechanics</td>
</tr>
<tr>
<td>CHEM 131C</td>
<td>Thermodynamics and Chemical Dynamics</td>
</tr>
<tr>
<td>PHRMSCI 170A</td>
<td>Molecular Pharmacology I</td>
</tr>
<tr>
<td>PHRMSCI 171</td>
<td>Physical Biochemistry</td>
</tr>
</tbody>
</table>

No course may be used to satisfy more than one requirement.

**Application Process to Declare the Major:** The major in Biochemistry and Molecular Biology is open to junior- and senior-level students only. Applications to declare the major can be made at any time, but typically in the spring of the sophomore year. Review of applications submitted at that time and selection to the major by the Biochemistry and Molecular Biology Faculty Board is completed during the summer. Information can also be found at the UCI Change of Major Criteria website (http://www.changeofmajor.uci.edu). Double majors within the Francisco J. Ayala School of Biological Sciences or with Public Health Sciences, Biomedical Engineering: Premedical, Nursing Science, or Pharmaceutical Sciences are not permitted.

**Sample Program — Biochemistry and Molecular Biology**

<table>
<thead>
<tr>
<th>Semester</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>BIO SCI 93</td>
<td>BIO SCI 94</td>
<td>CHEM 1C- 1LC</td>
</tr>
<tr>
<td></td>
<td>CHEM 1A</td>
<td>CHEM 1B</td>
<td>HUMAN 1C</td>
</tr>
<tr>
<td></td>
<td>HUMAN 1A¹</td>
<td>HUMAN 1B</td>
<td>HUMAN 1CS</td>
</tr>
<tr>
<td></td>
<td>HUMAN 1AS¹</td>
<td>HUMAN 1BS</td>
<td>MATH 2A</td>
</tr>
<tr>
<td></td>
<td>BIO SCI 2A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sophomore</td>
<td>BIO SCI 97</td>
<td>BIO SCI 98</td>
<td>BIO SCI 99</td>
</tr>
<tr>
<td></td>
<td>CHEM 51A²</td>
<td>CHEM 51B- 51LB</td>
<td>CHEM 51C- 51LC</td>
</tr>
<tr>
<td></td>
<td>CHEM 1LD</td>
<td>General Ed.</td>
<td>STATS 7, 8, MATH 2D, or MATH 3A</td>
</tr>
<tr>
<td></td>
<td>MATH 2B</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BIO SCI 194S</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junior</td>
<td>Biochem./Mol. elective</td>
<td>BIO SCI M114</td>
<td>BIO SCI M116</td>
</tr>
<tr>
<td></td>
<td>Research/Elective</td>
<td>Biochem./Mol. elective</td>
<td>Biochem./Mol. elective</td>
</tr>
<tr>
<td></td>
<td>BIO SCI 100</td>
<td>BIO SCI M114L</td>
<td>PHYSICS 3C- 3LC</td>
</tr>
<tr>
<td></td>
<td>PHYSICS 3A</td>
<td>PHYSICS 3B- 3LB</td>
<td></td>
</tr>
<tr>
<td>Senior</td>
<td>Biochem./Mol. elective</td>
<td>Bio. Sci. elective or lab</td>
<td>Bio. Sci. elective or lab</td>
</tr>
<tr>
<td></td>
<td>Research/Elective</td>
<td>Research/Elective</td>
<td>Research/Elective</td>
</tr>
<tr>
<td></td>
<td>General Ed./Elective</td>
<td>General Ed./Elective</td>
<td>General Ed./Elective</td>
</tr>
<tr>
<td></td>
<td>General Ed./Elective</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ Students have the option of taking HUMAN 1A and HUMAN 1AS or lower-division writing courses.

² CHEM H52A-CHEM H52B-CHEM H52C, CHEM H52LA-CHEM H52LB may be taken instead of CHEM 51A-CHEM 51B-CHEM 51C, CHEM 51LB-CHEM 51LC.
Undergraduate Major in Developmental and Cell Biology

The Developmental and Cell Biology major is intended to provide students with intensive training in cutting edge approaches to understanding the structure and function of cells and how they interact to produce a complex organism, starting with a fertilized egg. The focus of the B.S. in Developmental and Cell Biology is to provide students with intensive training aimed at preparing them for graduate programs in modern Developmental and Cell Biology or other biomedical sciences. In-depth training in the molecular basis of cell and developmental biology will be coupled with integrating knowledge obtained from the recent explosive advances in genomic technology to provide a strong working understanding of how to approach problems in basic research.

The major has distinctive features. The first is a reduction in the number of required courses, allowing students the opportunity to focus more deeply on training in Developmental and Cell Biology. The second is the implementation of a new course in Genomic and Proteomic analysis that is closely tied to problems in genetics, developmental, and cell biology. Understanding the connections among these disciplines and how to apply the appropriate tools for defining and answering fundamental questions in biomedical research is a critical tool for success in research. Another distinctive feature of the major is the opportunity to replace two upper-division laboratory courses with mentored BIO SCI 199 individual research in faculty laboratories. This offers students the opportunity to apply the tools they have acquired during formal course work to current problems at the frontiers of research. Lastly, students majoring in Developmental and Cell Biology have faculty advisors with whom they meet at least quarterly. The faculty advisors help students plan their curriculum, select appropriate 199 projects and sponsoring labs, and as a group grant petitions and certify the degree. The combination of new upper-division courses, more flexibility in the curriculum, the option for mentored research, and close interaction with faculty advisors will help the Developmental and Cell Biology majors to develop an appreciation of the nature of research and establish a strong foundation for future success in graduate or professional schools.

Requirements for the B.S. Degree in Developmental and Cell Biology

All students must meet the University Requirements.

All students must meet the School Requirements.

Major Requirements

A. Required Major Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI D103</td>
<td>Cell Biology</td>
</tr>
<tr>
<td>BIO SCI D104</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>BIO SCI D114</td>
<td>Developmental and Cell Biology Majors Seminar</td>
</tr>
<tr>
<td>BIO SCI D145</td>
<td>Genomics, Development, and Medicine</td>
</tr>
</tbody>
</table>

B. Upper-Division Laboratories:

- BIO SCI D111L Developmental and Cell Biology Laboratory

and select two of the following:¹

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI E106L</td>
<td>Habitats and Organisms</td>
</tr>
<tr>
<td>BIO SCI E112L</td>
<td>Physiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI E115L</td>
<td>Evolution Laboratory</td>
</tr>
<tr>
<td>BIO SCI E131L</td>
<td>Image Analysis in Biological Research</td>
</tr>
<tr>
<td>BIO SCI E161L</td>
<td>Biology of Birds Lab</td>
</tr>
<tr>
<td>BIO SCI E166L</td>
<td>Field Biology</td>
</tr>
<tr>
<td>BIO SCI E172L</td>
<td>Plant Systematics Laboratory</td>
</tr>
<tr>
<td>BIO SCI E179L</td>
<td>Field Freshwater Ecology</td>
</tr>
<tr>
<td>BIO SCI M114L</td>
<td>Biochemistry Laboratory</td>
</tr>
<tr>
<td>BIO SCI M116L</td>
<td>Molecular Biology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M118L</td>
<td>Experimental Microbiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M121L</td>
<td>Advanced Immunology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M122L</td>
<td>Advanced Microbiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M124L</td>
<td>Virus Engineering Laboratory</td>
</tr>
<tr>
<td>BIO SCI M127L</td>
<td>Virology and Immunology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M130L</td>
<td>Advanced Molecular Lab Techniques</td>
</tr>
<tr>
<td>BIO SCI N113L</td>
<td>Neurobiology Laboratory</td>
</tr>
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</table>

C. Upper-Division Biology Electives:

Select one of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
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<tbody>
<tr>
<td>BIO SCI D136</td>
<td>Human Anatomy</td>
</tr>
<tr>
<td>BIO SCI D137</td>
<td>Eukaryotic and Human Genetics</td>
</tr>
<tr>
<td>BIO SCI D148</td>
<td>Development and Disease</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
</tr>
<tr>
<td>------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>BIO SCI D121</td>
<td>Stem Cell Biology</td>
</tr>
<tr>
<td>BIO SCI D135</td>
<td>Cell Biology of Human Disease</td>
</tr>
<tr>
<td>BIO SCI D190</td>
<td>Topics in Developmental and Cell Biology</td>
</tr>
<tr>
<td>BIO SCI M120</td>
<td>Signal Transduction in Mammalian Cells</td>
</tr>
<tr>
<td>BIO SCI M144</td>
<td>Cell Organelles and Membranes</td>
</tr>
</tbody>
</table>

and select three of the following:

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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI D105</td>
<td>Cell, Developmental, and Molecular Biology of Plants</td>
</tr>
<tr>
<td>BIO SCI D129</td>
<td>Biotechnology and Plant Breeding</td>
</tr>
<tr>
<td>BIO SCI D130</td>
<td>Photomedicine</td>
</tr>
<tr>
<td>BIO SCI D132</td>
<td>Introduction to Personalized Medicine</td>
</tr>
<tr>
<td>BIO SCI D133</td>
<td>Advances in Regenerative Medicine</td>
</tr>
<tr>
<td>BIO SCI D136</td>
<td>Human Anatomy</td>
</tr>
<tr>
<td>BIO SCI D137</td>
<td>Eukaryotic and Human Genetics</td>
</tr>
<tr>
<td>BIO SCI D148</td>
<td>Development and Disease</td>
</tr>
<tr>
<td>BIO SCI E109</td>
<td>Human Physiology</td>
</tr>
<tr>
<td>BIO SCI E157</td>
<td>Comparative Vertebrate Anatomy</td>
</tr>
<tr>
<td>BIO SCI M114</td>
<td>Advanced Biochemistry</td>
</tr>
<tr>
<td>BIO SCI M116</td>
<td>Advanced Molecular Biology</td>
</tr>
<tr>
<td>BIO SCI M125</td>
<td>Molecular Biology of Cancer</td>
</tr>
<tr>
<td>BIO SCI M137</td>
<td>Microbial Genetics</td>
</tr>
<tr>
<td>BIO SCI M143</td>
<td>Human Parasitology</td>
</tr>
<tr>
<td>BIO SCI M144</td>
<td>Cell Organelles and Membranes</td>
</tr>
<tr>
<td>BIO SCI N110</td>
<td>Neurobiology and Behavior</td>
</tr>
<tr>
<td>BIO SCI N151</td>
<td>Neurobiology of Aging</td>
</tr>
<tr>
<td>BIO SCI N153</td>
<td>Neuropharmacology</td>
</tr>
<tr>
<td>BIO SCI N154</td>
<td>Molecular Neurobiology</td>
</tr>
</tbody>
</table>

1 Students may petition to substitute Excellence in Research (BIO SCI 199) for two upper-division laboratories (other than BIO SCI D111L); 199 research is strongly encouraged. The 199 laboratory must be approved by the Department, and Excellence in Research must be successfully completed. Final approval is given by the Department.

**Application Process to Declare the Major:** The major in Developmental and Cell Biology is open to junior- and senior-level students only. Applications to declare the major can be made at any time. Information can also be found at the UCI Change of Major Criteria website (http://www.changeofmajor.uci.edu). Double majors within the Francisco J. Ayala School of Biological Sciences or with Public Health Sciences, Biomedical Engineering: Premedical, Nursing Science, or Pharmaceutical Sciences are not permitted.

**Sample Program — Developmental and Cell Biology**

**Freshman**

<table>
<thead>
<tr>
<th>Term</th>
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<th>Courses</th>
</tr>
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<tbody>
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<td>Fall</td>
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<tr>
<td>CHEM 1A</td>
<td>BIO SCI 98</td>
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</tr>
<tr>
<td>HUMAN 1A1</td>
<td>CHEM 1B</td>
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<tr>
<td>HUMAN 1A1</td>
<td>HUMAN 1B</td>
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<td>HUMAN 1AS1</td>
<td>HUMAN 1BS</td>
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<td>BIO SCI 2A</td>
<td>CHEM 51A</td>
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<table>
<thead>
<tr>
<th>Term</th>
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<tbody>
<tr>
<td>Fall</td>
<td>BIO SCI 97</td>
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<td>CHEM 51A2</td>
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**Sophomore**

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<td>Fall</td>
<td>BIO SCI D103</td>
<td>BIO SCI D104</td>
</tr>
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<td>PHYSICS 3A</td>
<td>PHYSICS 3B- 3LB</td>
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</tr>
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<td>BIO SCI 100</td>
<td>BIO SCI D145</td>
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<table>
<thead>
<tr>
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<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
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<td>BIO SCI D111L</td>
<td>BIO SCI D111L</td>
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<td>PHYSICS 3C- 3LC</td>
<td>PHYSICS 3C- 3LC</td>
<td></td>
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<tr>
<td>BIO SCI D114</td>
<td>BIO SCI D114</td>
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<tr>
<td>General Ed.</td>
<td>General Ed.</td>
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</tr>
</tbody>
</table>
Undergraduate Major in Ecology and Evolutionary Biology

In the twenty-first century, biologists in fields ranging from medicine to global change biology increasingly incorporate ecological and evolutionary ideas in their research. The major in Ecology and Evolutionary Biology encourages students to understand and appreciate important linkages between biological disciplines. The major is very broad, including components of evolutionary biology, ecology, and physiology. Faculty interests are also broad and include the evolution of aging, conservation biology, restoration ecology, biogeography, plant and animal population and community ecology, the evolution of infectious disease, evolutionary physiology, behavioral ecology, host-disease interactions, evolutionary genetics, genetics of invasive species, and plant population biology. Following graduation, students will be especially well prepared to enter graduate programs in either ecology or evolution for advanced study. The major also provides the foundation to pursue careers in governmental and non-governmental environmental organizations, as well as professional schools. The Department considers undergraduate experience in research an integral component of a scientific education, and majors are encouraged to participate in BIO SCI 199, in which they will be mentored by an individual faculty member within the Department.

Requirements for the B.S. Degree in Ecology and Evolutionary Biology

All students must meet the University Requirements.
All students must meet the School Requirements.

Major Requirements

A. Required Major Courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>BIO SCI E106</td>
<td>Processes in Ecology and Evolution</td>
</tr>
<tr>
<td>BIO SCI E107</td>
<td>Seminar in Ecology and Evolutionary Biology</td>
</tr>
<tr>
<td>STATS 8</td>
<td>Introduction to Biological Statistics</td>
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B. Upper-Division Laboratories:

<table>
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<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>BIO SCI E115L</td>
<td>Evolution Laboratory</td>
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<tr>
<td>BIO SCI E166L</td>
<td>Field Biology</td>
</tr>
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</table>

and select one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI D111L</td>
<td>Developmental and Cell Biology Laboratory</td>
</tr>
<tr>
<td>BIO SCI E106L</td>
<td>Habitats and Organisms</td>
</tr>
<tr>
<td>BIO SCI E112L</td>
<td>Physiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI E131L</td>
<td>Image Analysis in Biological Research</td>
</tr>
<tr>
<td>BIO SCI E161L</td>
<td>Biology of Birds Lab</td>
</tr>
<tr>
<td>BIO SCI E172L</td>
<td>Plant Systematics Laboratory</td>
</tr>
<tr>
<td>BIO SCI E179L</td>
<td>Field Freshwater Ecology</td>
</tr>
<tr>
<td>BIO SCI M114L</td>
<td>Biochemistry Laboratory</td>
</tr>
<tr>
<td>BIO SCI M116L</td>
<td>Molecular Biology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M118L</td>
<td>Experimental Microbiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M121L</td>
<td>Advanced Immunology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M122L</td>
<td>Advanced Microbiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M124L</td>
<td>Virus Engineering Laboratory</td>
</tr>
<tr>
<td>BIO SCI M127L</td>
<td>Virology and Immunology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M130L</td>
<td>Advanced Molecular Lab Techniques</td>
</tr>
<tr>
<td>BIO SCI N113L</td>
<td>Neurobiology Laboratory</td>
</tr>
</tbody>
</table>

One laboratory can be satisfied with completion of Excellence in Research in the Biological Sciences.

C. Upper-Division Biology Electives:

Select one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI D103</td>
<td>Cell Biology</td>
</tr>
</tbody>
</table>

1 Students have the option of taking HUMAN 1A and HUMAN 1AS or lower-division writing courses.
2 CHEM H52A-CHEM H52B-CHEM H52C, CHEM H52LA-CHEM H52LB may be taken instead of CHEM 51A-CHEM 51B-CHEM 51C, CHEM 51LB-CHEM 51LC.
and select three four-unit courses from the following:
BIO SCI E118–E190. BIO SCI 199 Research is strongly encouraged.

Double majors within the Francisco J. Ayala School of Biological Sciences or with Public Health Sciences, Biomedical Engineering: Premedical, Nursing Science, or Pharmaceutical Sciences are not permitted.

**Sample Program — Ecology and Evolutionary Biology**

**Freshman**

<table>
<thead>
<tr>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI 93</td>
<td>BIO SCI 94</td>
<td>BIO SCI E106&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>CHEM 1A</td>
<td>CHEM 1B</td>
<td>CHEM 1C- 1LC</td>
</tr>
<tr>
<td>HUMAN 1A&lt;sup&gt;1&lt;/sup&gt;</td>
<td>HUMAN 1B</td>
<td>HUMAN 1C</td>
</tr>
<tr>
<td>HUMAN 1AS&lt;sup&gt;1&lt;/sup&gt;</td>
<td>HUMAN 1BS</td>
<td>HUMAN 1CS</td>
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<td>BIO SCI 2A</td>
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**Sophomore**

<table>
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<td>BIO SCI 97</td>
<td>BIO SCI 98</td>
<td>BIO SCI 99</td>
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<tr>
<td>CHEM 51A&lt;sup&gt;3&lt;/sup&gt;</td>
<td>CHEM 51B- 51LB</td>
<td>CHEM 51C- 51LC</td>
</tr>
<tr>
<td>MATH 2A</td>
<td>MATH 2B</td>
<td>STATS 8</td>
</tr>
<tr>
<td>CHEM 1LD</td>
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<tr>
<td>BIO SCI 194S</td>
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**Junior**

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>BIO SCI E107</td>
<td>U-D Bio. Sci. elective</td>
<td>BIO SCI E115L</td>
</tr>
<tr>
<td>PHYSICS 3A</td>
<td>PHYSICS 3B- 3LB</td>
<td>PHYSICS 3C- 3LC</td>
</tr>
<tr>
<td>General Ed.</td>
<td>BIO SCI 100</td>
<td>Bio. Sci. research</td>
</tr>
</tbody>
</table>

**Senior**

<table>
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<tr>
<th>Fall</th>
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<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-D Lab</td>
<td>Bio. Sci. research</td>
<td>General Ed.</td>
</tr>
</tbody>
</table>

1. Students have the option of taking HUMAN 1A and HUMAN 1AS or lower-division writing courses.
2. BIO SCI E106 is offered in all three quarters, is a prerequisite for many upper-division courses and may be taken at any time after completion of BIO SCI 94.
3. CHEM H52A-CHEM H52B-CHEM H52C, CHEM H52LA-CHEM H52LB may be taken instead of CHEM 51A-CHEM 51B-CHEM 51C, CHEM 51LB-CHEM 51LC.

**Undergraduate Major in Exercise Sciences**

Virtually every organism is dependent on movement (both intracellular and extracellular) in one form or another. With respect to humans, physical activity imposes unique stresses on a broad spectrum of cell types, tissues, and organ systems. In so doing, physical activity plays a key role in shaping fundamental biological processes necessary for maintaining health and preventing disease. While both human and nonhuman species exhibit many common biological phenomenon, there are also many unique aspects of their physiology. This major will also highlight some of the unique physiological traits of nonhuman species and how such unique phenomenon may provide important insights into human health. Upper-division courses in this major are designed to integrate fundamental principles of biology, chemistry, and physics into a coherent understanding of how physical activity/inactivity impacts human health under healthy and diseased states.
Requirements for the B.S. Degree in Exercise Sciences

All students must meet the University Requirements.
All students must meet the School Requirements.

Major Requirements

A. Required Major Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI D103</td>
<td>Cell Biology</td>
</tr>
<tr>
<td>BIO SCI E109</td>
<td>Human Physiology</td>
</tr>
<tr>
<td>BIO SCI E117A- E117B- E117C</td>
<td>Exercise Sciences Seminar</td>
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<tr>
<td>BIO SCI E117A- E117B- E117C</td>
<td>Exercise Sciences Seminar</td>
</tr>
<tr>
<td>BIO SCI E117A- E117B- E117C</td>
<td>Exercise Sciences Seminar</td>
</tr>
<tr>
<td>BIO SCI E136</td>
<td>The Physiology of Human Nutrition</td>
</tr>
<tr>
<td>BIO SCI E155</td>
<td>Physiology in Extreme Environments</td>
</tr>
<tr>
<td>BIO SCI E170</td>
<td>Exercise Physiology</td>
</tr>
<tr>
<td>BIO SCI N110</td>
<td>Neurobiology and Behavior</td>
</tr>
</tbody>
</table>

B. Upper-Division Laboratories:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI E112L</td>
<td>Physiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M116L</td>
<td>Molecular Biology Laboratory</td>
</tr>
</tbody>
</table>

and either

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>BIO SCI N113L</td>
<td>Neurobiology Laboratory</td>
</tr>
<tr>
<td>or BIO SCI M114L</td>
<td>Biochemistry Laboratory</td>
</tr>
</tbody>
</table>

Application Process to Declare the Major: The major in Exercise Sciences is open to junior- and senior-level students only. Applications to declare the major can be submitted during the spring of the sophomore year. Review of applications submitted at that time and selection to the major by the Exercise Science Faculty Board is completed at the end of the sophomore year. Information can also be found at UCI Change of Major Criteria website (http://www.changeofmajor.uci.edu). Double majors within the School of Biological Sciences or with Public Health Sciences, Biomedical Engineering: Premedical, Nursing Science, or Pharmaceutical Sciences are not permitted.

Sample Program — Exercise Sciences

<table>
<thead>
<tr>
<th>Year</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>BIO SCI 93</td>
<td>BIO SCI 94</td>
<td>MATH 2A</td>
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<tr>
<td></td>
<td>CHEM 1A</td>
<td>CHEM 1B</td>
<td>CHEM 1C- 1LC</td>
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<tr>
<td></td>
<td>HUMAN 1A</td>
<td>HUMAN 1B</td>
<td>HUMAN 1C</td>
</tr>
<tr>
<td></td>
<td>HUMAN 1AS¹</td>
<td>HUMAN 1BS</td>
<td>HUMAN 1CS</td>
</tr>
<tr>
<td></td>
<td>BIO SCI 2A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sophomore</td>
<td>BIO SCI 97</td>
<td>BIO SCI 98</td>
<td>BIO SCI 99</td>
</tr>
<tr>
<td></td>
<td>CHEM 51A</td>
<td>CHEM 51B- 51LB</td>
<td>CHEM 51C- 51LC</td>
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<tr>
<td></td>
<td>CHEM 1LD</td>
<td>General Education</td>
<td>STATS 7 or 8</td>
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<td>MATH 2B</td>
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<td>General Education</td>
</tr>
<tr>
<td></td>
<td>BIO SCI 194S</td>
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<tr>
<td>Junior</td>
<td>BIO SCI D103</td>
<td>BIO SCI E183</td>
<td>BIO SCI N110</td>
</tr>
<tr>
<td></td>
<td>PHYSICS 3A</td>
<td>PHYSICS 3B- 3LB</td>
<td>BIO SCI E170</td>
</tr>
<tr>
<td></td>
<td>BIO SCI E109</td>
<td>BIO SCI E112L</td>
<td>PHYSICS 3C- 3LC</td>
</tr>
<tr>
<td></td>
<td>BIO SCI 100</td>
<td></td>
<td>BIO SCI 199</td>
</tr>
<tr>
<td>Senior</td>
<td>BIO SCI E155</td>
<td>BIO SCI E136</td>
<td>BIO SCI M114L or N113L</td>
</tr>
<tr>
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<td>BIO SCI M116L</td>
<td>General Education</td>
<td>General Education</td>
</tr>
<tr>
<td></td>
<td>BIO SCI 199</td>
<td>BIO SCI 199</td>
<td>BIO SCI 199</td>
</tr>
<tr>
<td></td>
<td>BIO SCI E117A</td>
<td>BIO SCI E117B</td>
<td>BIO SCI E117C</td>
</tr>
</tbody>
</table>

¹ Students have the option of taking HUMAN 1A and HUMAN 1AS or lower-division writing courses.
Undergraduate Major in Genetics

Genetics pervades every aspect of modern society, from newspaper articles to talk shows, from discussions on health care to discussions on cloning. With the sequencing of the human genome, it is more important than ever for biology students to have a broad background in the study of heredity and evolution. The Genetics major is designed to benefit motivated undergraduates who have a particular interest in learning about developmental genetics, evolutionary genetics, and molecular genetics and to allow them to explore how our knowledge of genetic mechanisms contributes to our understanding of human development and disease. The Genetics major will accommodate students interested in the study of inheritance either as a basic discipline or in terms of its applied aspects in biotechnology, medicine, and agriculture, but will be especially attractive to those students desiring focused study and preparation for graduate training.

Genetics majors begin their study in the junior year with two Genetics courses (BIO SCI M137 and BIO SCI D137) and a Genomics and Proteomics course (BIO SCI D145). This series of courses is designed to give students an understanding of genetic mechanisms and teach them how to define and answer fundamental questions in biomedical research. Additionally, students choose at least two electives that deal with topics such as the molecular biology of cancer, human genetic diseases, developmental genetics, and the genetics of aging. Finally, Genetics majors are encouraged to explore laboratory research by enrolling in BIO SCI 199. Laboratory research not only expands a student’s technical skills, but is also designed to allow faculty members to mentor Genetics majors. All students majoring in Genetics have a faculty advisor with whom they meet at least quarterly. The faculty advisor helps students plan their curriculum and select appropriate Biological Sciences 199 research projects. Genetics majors also have an opportunity to meet with other Genetics majors on a regular basis and participate in research talks.

The Genetics major provides graduates with advanced training in the skills necessary to pursue graduate degrees in biomedical research. These include Ph.D. graduate programs, teacher-training programs, medical school, and veterinary school. Genetics graduates may also use their backgrounds effectively in planning careers in law, business, education, and public affairs.

Requirements for the B.S. Degree in Genetics

All students must meet the University Requirements.
All students must meet the School Requirements.

Major Requirements

A. Required Major Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI D103</td>
<td>Cell Biology</td>
</tr>
<tr>
<td>BIO SCI D104</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>BIO SCI D113</td>
<td>Genetics Majors Seminar</td>
</tr>
<tr>
<td>BIO SCI D132</td>
<td>Introduction to Personalized Medicine</td>
</tr>
<tr>
<td>BIO SCI D137</td>
<td>Eukaryotic and Human Genetics</td>
</tr>
<tr>
<td>BIO SCI D145</td>
<td>Genomics, Development, and Medicine</td>
</tr>
<tr>
<td>BIO SCI M137</td>
<td>Microbial Genetics</td>
</tr>
</tbody>
</table>

B. Upper-Division Laboratories:

Select three of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI D111L</td>
<td>Developmental and Cell Biology Laboratory</td>
</tr>
<tr>
<td>BIO SCI E106L</td>
<td>Habitats and Organisms</td>
</tr>
<tr>
<td>BIO SCI E112L</td>
<td>Physiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI E115L</td>
<td>Evolution Laboratory</td>
</tr>
<tr>
<td>BIO SCI E131L</td>
<td>Image Analysis in Biological Research</td>
</tr>
<tr>
<td>BIO SCI E161L</td>
<td>Biology of Birds Lab</td>
</tr>
<tr>
<td>BIO SCI E166L</td>
<td>Field Biology</td>
</tr>
<tr>
<td>BIO SCI E172L</td>
<td>Plant Systematics Laboratory</td>
</tr>
<tr>
<td>BIO SCI E179L</td>
<td>Field Freshwater Ecology</td>
</tr>
<tr>
<td>BIO SCI M114L</td>
<td>Biochemistry Laboratory</td>
</tr>
<tr>
<td>BIO SCI M116L</td>
<td>Molecular Biology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M118L</td>
<td>Experimental Microbiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M121L</td>
<td>Advanced Immunology Laboratory</td>
</tr>
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<td>BIO SCI M122L</td>
<td>Advanced Microbiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M124L</td>
<td>Virus Engineering Laboratory</td>
</tr>
<tr>
<td>BIO SCI M127L</td>
<td>Virology and Immunology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M130L</td>
<td>Advanced Molecular Lab Techniques</td>
</tr>
<tr>
<td>BIO SCI N113L</td>
<td>Neurobiology Laboratory</td>
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C. Upper-Division Biology Electives:
Select two of the following:

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<td>Cell, Developmental, and Molecular Biology of Plants</td>
</tr>
<tr>
<td>BIO SCI D121</td>
<td>Stem Cell Biology</td>
</tr>
<tr>
<td>BIO SCI D129</td>
<td>Biotechnology and Plant Breeding</td>
</tr>
<tr>
<td>BIO SCI D130</td>
<td>Photomedicine</td>
</tr>
<tr>
<td>BIO SCI D133</td>
<td>Advances in Regenerative Medicine</td>
</tr>
<tr>
<td>BIO SCI D135</td>
<td>Cell Biology of Human Disease</td>
</tr>
<tr>
<td>BIO SCI D136</td>
<td>Human Anatomy</td>
</tr>
<tr>
<td>BIO SCI D148</td>
<td>Development and Disease</td>
</tr>
<tr>
<td>BIO SCI D170</td>
<td>Applied Human Anatomy</td>
</tr>
<tr>
<td>BIO SCI D190</td>
<td>Topics in Developmental and Cell Biology</td>
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<tr>
<td>BIO SCI E109</td>
<td>Human Physiology</td>
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<td>BIO SCI E137</td>
<td>Genetics of Complex Traits</td>
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<tr>
<td>BIO SCI E153</td>
<td>Functional and Structural Evolutionary Genomics</td>
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<td>BIO SCI M114</td>
<td>Advanced Biochemistry</td>
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<td>BIO SCI M116</td>
<td>Advanced Molecular Biology</td>
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<td>BIO SCI M120</td>
<td>Signal Transduction in Mammalian Cells</td>
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<td>BIO SCI M125</td>
<td>Molecular Biology of Cancer</td>
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<td>BIO SCI M143</td>
<td>Human Parasitology</td>
</tr>
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<td>BIO SCI M144</td>
<td>Cell Organelles and Membranes</td>
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<tr>
<td>BIO SCI N110</td>
<td>Neurobiology and Behavior</td>
</tr>
<tr>
<td>BIO SCI N151</td>
<td>Neurobiology of Aging</td>
</tr>
<tr>
<td>BIO SCI N154</td>
<td>Molecular Neurobiology</td>
</tr>
</tbody>
</table>

1 Students may petition to substitute Excellence in Research (Bio Sci 199) for two upper-division laboratories; 199 research is strongly encouraged. The 199 laboratory must be approved by the Department, and Excellence in Research must be successfully completed. Final approval is given by the Department.

Application Process to Declare the Major: The major in Genetics is open to junior- and senior-level students only. Applications to declare the major can be made at any time. Information can also be found at the UCI Change of Major Criteria (http://www.changeofmajor.uci.edu) website (http://www.changeofmajor.uci.edu). Double majors within the Francisco J. Ayala School of Biological Sciences or with Public Health Sciences, Biomedical Engineering: Premedical, Nursing Science, or Pharmaceutical Sciences are not permitted.

Sample Program — Genetics

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
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<tbody>
<tr>
<td>BIO SCI 93</td>
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<td>BIO SCI 94</td>
<td>CHEM 1C-1LC</td>
</tr>
<tr>
<td>CHEM 1A</td>
<td>CHEM 1B</td>
<td>HUMAN 1B</td>
<td>HUMAN 1C</td>
</tr>
<tr>
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<td>HUMAN 1BS</td>
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<td>HUMAN 1CS</td>
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<tr>
<td>HUMAN 1A</td>
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<td>BIO SCI 194S</td>
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<tr>
<td>HUMAN 1AS</td>
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<td>BIO SCI 99</td>
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<td>CHEM 51B-51LB</td>
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<td>CHEM 51C-51LC</td>
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<td>MATH 2D, 3A, STATS 7, or STATS 8</td>
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<thead>
<tr>
<th>Junior</th>
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<th>Winter</th>
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<tbody>
<tr>
<td>BIO SCI D103</td>
<td>BIO SCI D103</td>
<td>BIO SCI D104</td>
<td>U-D Lab or BIO SCI 199</td>
</tr>
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<td>PHYSICS 3B-3LB</td>
<td>PHYSICS 3C-3LC</td>
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<td>BIO SCI D137</td>
<td>BIO SCI M137</td>
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<td>BIO SCI D113</td>
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<table>
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<tr>
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<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td>U-D Lab or BIO SCI 199</td>
<td>U-D Lab or BIO SCI 199</td>
<td>U-D Bio. Sci. elective</td>
<td></td>
</tr>
</tbody>
</table>
Students have the option of taking HUMAN 1A and HUMAN 1AS or lower-division writing courses.

CHEM H52A-CHEM H52B-CHEM H52C, CHEM H52LA-CHEM H52LB may be taken instead of CHEM 51A-CHEM 51B-CHEM 51C, CHEM 51LB-CHEM 51LC.

Undergraduate Major in Human Biology

Understanding normal and disordered human function both require a broad integration of human physiology, behavior, and culture that is provided in this major. Students in this major will receive a unified, in-depth study of modern biology that includes ecology, evolutionary biology, genetics, biochemistry, molecular biology, cell biology, human physiology, neurobiology, and behavior. In addition, the skills and concepts needed to pursue this field are presented in upper-division laboratories. Advanced elective courses provide an opportunity to diversify exposure to the biological sciences. Additional courses in the humanities and social sciences focus on the relevance of these areas to the human condition. Given the focus on human biology, this major will serve as an ideal preparation for the health science professions.

Requirements for the B.S. Degree in Human Biology

All students must meet the University Requirements.

All students must meet the School Requirements.

Major Requirements

A. Required Major Courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>BIO SCI D103</td>
<td>Cell Biology</td>
</tr>
<tr>
<td>BIO SCI E109</td>
<td>Human Physiology</td>
</tr>
<tr>
<td>BIO SCI N110</td>
<td>Neurobiology and Behavior</td>
</tr>
<tr>
<td>BIO SCI N120</td>
<td>Human Biology</td>
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B. Upper-Division Laboratories:

Select three of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>BIO SCI D111L</td>
<td>Developmental and Cell Biology Laboratory</td>
</tr>
<tr>
<td>BIO SCI E106L</td>
<td>Habitats and Organisms</td>
</tr>
<tr>
<td>BIO SCI E112L</td>
<td>Physiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI E115L</td>
<td>Evolution Laboratory</td>
</tr>
<tr>
<td>BIO SCI E131L</td>
<td>Image Analysis in Biological Research</td>
</tr>
<tr>
<td>BIO SCI E161L</td>
<td>Biology of Birds Lab</td>
</tr>
<tr>
<td>BIO SCI E166L</td>
<td>Field Biology</td>
</tr>
<tr>
<td>BIO SCI E172L</td>
<td>Plant Systematics Laboratory</td>
</tr>
<tr>
<td>BIO SCI E179L</td>
<td>Field Freshwater Ecology</td>
</tr>
<tr>
<td>BIO SCI M114L</td>
<td>Biochemistry Laboratory</td>
</tr>
<tr>
<td>BIO SCI M116L</td>
<td>Molecular Biology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M118L</td>
<td>Experimental Microbiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M121L</td>
<td>Advanced Immunology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M122L</td>
<td>Advanced Microbiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M124L</td>
<td>Virus Engineering Laboratory</td>
</tr>
<tr>
<td>BIO SCI M127L</td>
<td>Virology and Immunology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M130L</td>
<td>Advanced Molecular Lab Techniques</td>
</tr>
<tr>
<td>BIO SCI N113L</td>
<td>Neurobiology Laboratory</td>
</tr>
</tbody>
</table>

One laboratory can be satisfied with completion of Excellence in Research in the Biological Sciences.

C. Upper-Division Biology Electives:

Select four upper-division, four-unit courses from the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHRMSCI 170A</td>
<td>Molecular Pharmacology I</td>
</tr>
<tr>
<td>PHRMSCI 170B</td>
<td>Molecular Pharmacology II</td>
</tr>
<tr>
<td>PHRMSCI 171</td>
<td>Physical Biochemistry</td>
</tr>
<tr>
<td>PHRMSCI 173</td>
<td>Pharmacotherapy</td>
</tr>
<tr>
<td>PHRMSCI 174</td>
<td>Biopharmaceutics and Nanomedicine</td>
</tr>
<tr>
<td>PHRMSCI 177</td>
<td>Medicinal Chemistry</td>
</tr>
</tbody>
</table>
The following courses can be used to partially satisfy the Upper-Division Biology Elective Requirement:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 131A-131B-131C</td>
<td>Quantum Principles and Molecular Structure and Elementary Statistical Mechanics and Thermodynamics and Chemical Dynamics</td>
</tr>
</tbody>
</table>

or

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYSICS 147A-147B</td>
<td>Principles of Imaging and Techniques in Medical Imaging I: X-ray, Nuclear, and NMR Imaging</td>
</tr>
</tbody>
</table>

Additionally, Psychology/Biological Sciences double majors may also use PSYCH 112A-PSYCH 112B-PSYCH 112C to partially satisfy the Upper-Division Biology Elective Requirement.

D. Behavioral Science Courses (choose 1 option):

Option 1

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>ANTHRO 2A</td>
<td>Introduction to Sociocultural Anthropology</td>
</tr>
<tr>
<td>PSYCH 7A</td>
<td>Introduction to Psychology</td>
</tr>
<tr>
<td>SOCIOL 1</td>
<td>Introduction to Sociology</td>
</tr>
</tbody>
</table>

Option 2

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>SOC SCI H1E- H1F- H1G</td>
<td>Honors: Critical Issues on the Social Sciences and Honors: Critical Issues on the Social Sciences and Honors: Critical Issues on the Social Sciences</td>
</tr>
</tbody>
</table>

E. HUMAN 1A-HUMAN 1AS-HUMAN 1B-HUMAN 1BS-HUMAN 1C-HUMAN 1CS.

F. BIO SCI 3A.

1 One laboratory can be satisfied with completion of Excellence in Research in the Biological Sciences.

2 BIO SCI D103, BIO SCI D104, BIO SCI D105, BIO SCI E106, BIO SCI E109, BIO SCI N110 may not be used to satisfy more than one requirement.

Application Process to Declare the Major: The major in Human Biology is open to junior- and senior-level students only. Applications to declare the major can be made at any time, but typically in the spring of the sophomore year. Review of applications submitted at that time and selection to the major by the Human Biology Faculty Board is completed during the summer. Information can also be found at the UCI Change of Major Criteria (http://www.changeofmajor.uci.edu) website (http://www.changeofmajor.uci.edu). Double majors within the School of Biological Sciences or with Public Health Sciences, Biomedical Engineering; Premedical, Nursing Science, or Pharmaceutical Sciences are not permitted.

Sample Program — Human Biology

<table>
<thead>
<tr>
<th>Year</th>
<th>Term</th>
<th>Courses</th>
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<tbody>
<tr>
<td>Freshman</td>
<td>Fall</td>
<td>BIO SCI 93</td>
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<tr>
<td></td>
<td>Winter</td>
<td>BIO SCI 94</td>
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<tr>
<td></td>
<td>Spring</td>
<td>MATH 2A</td>
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<tr>
<td></td>
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<td>CHEM 1A</td>
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<td>HUMAN 1A</td>
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<tr>
<td></td>
<td></td>
<td>BIO SCI 2A</td>
</tr>
<tr>
<td>Sophomore</td>
<td>Fall</td>
<td>BIO SCI 97</td>
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<tr>
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<td>Winter</td>
<td>BIO SCI 98</td>
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<tr>
<td></td>
<td></td>
<td>CHEM 51A</td>
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<tr>
<td></td>
<td></td>
<td>CHEM 1B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HUMAN 1B</td>
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<tr>
<td></td>
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<td>HUMAN 1BS</td>
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<tr>
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<td>MATH 2B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BIO SCI 194S</td>
</tr>
<tr>
<td>Junior</td>
<td>Fall</td>
<td>BIO SCI D103</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PHYSICS 3A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BIO SCI 100</td>
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<tr>
<td></td>
<td></td>
<td>BIO SCI N120</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>BIO SCI 3A</td>
</tr>
<tr>
<td></td>
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<td>PHYSICS 3B</td>
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<tr>
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<tr>
<td></td>
<td></td>
<td>Research</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BIO SCI Elective</td>
</tr>
<tr>
<td>Senior</td>
<td>Fall</td>
<td>BIO SCI Elective</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>BIO SCI Elective</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>BIO SCI Lab</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BIO SCI 199</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BIO SCI Elective</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BIO SCI Lab</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BIO SCI 199</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BIO SCI Elective</td>
</tr>
</tbody>
</table>
Undergraduate Major in Microbiology and Immunology

Microbiology and immunology are well-established disciplines within the life sciences. Microbiology addresses the biology of bacteria, viruses, and unicellular eukaryotes such as fungi and protozoa. Studies of microorganisms reveal basic information about processes in evolution, genetics, biochemistry, molecular biology, cell biology, structural biology, and ecology. Many bacteria, viruses, and protozoa cause disease in plants and animals. Hence, major areas of medicine and public health focus on these microorganisms.

Immunology encompasses efforts to understand how multicellular organisms have evolved to survive a variety of challenges to health and survival, including threats by pathogens and cancer cells. Basic questions of how immunity functions are entwined with a fundamental understanding of the consequences of microbial infection. Immunology also refers to the study of autoimmunity, the attack of the host by its own immune system.

The study of viruses (virology) is an important branch of microbiology that has contributed to our understanding of most of the fundamental processes in eukaryotic molecular biology, including the discovery of oncogenes. Viruses provide an excellent tool for the study of disease, cancer, and mechanisms of gene control. With the growing threat of emerging diseases and the potential for viral-based biological weapons, the study of virology was recently intensified and gained new perspectives.

The major has been designed to span the interconnected disciplines of Microbiology and Immunology, and because the scope of the disciplines is considerable, students have the opportunity to specialize within the major in one of three areas: microbiology, immunology, or virology. The curricula overlap considerably, but there are unique courses for each specialty. Students opting for the microbiology specialization can select from courses focused on prokaryotes (bacteria) or eukaryotes (parasites).

The major is designed primarily for students who are serious about pursuing careers in microbiology and immunology and is intended to provide its graduates with the appropriate tools and training to successfully pursue professional and graduate degrees emphasizing these disciplines. These include Ph.D., M.D., and combined M.D./Ph.D. programs. Majoring in Microbiology and Immunology will also provide resources for serious students wishing to use a solid background in these disciplines for career goals in business, law, public and environmental policy, education, and other pursuits.

Requirements for the B.S. Degree in Microbiology and Immunology

All students must meet the University Requirements.

All students must meet the School Requirements.

Major Requirements for the General Track in Microbiology and Immunology

A. Required Major Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI M121</td>
<td>Immunology with Hematology</td>
</tr>
<tr>
<td>BIO SCI M122</td>
<td>General Microbiology</td>
</tr>
<tr>
<td>BIO SCI M124A</td>
<td>Virology</td>
</tr>
</tbody>
</table>

B. Upper-Division Laboratories:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI M116L</td>
<td>Molecular Biology Laboratory</td>
</tr>
</tbody>
</table>

and either

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI M118L</td>
<td>Experimental Microbiology Laboratory</td>
</tr>
<tr>
<td>or BIO SCI M127L</td>
<td>Virology and Immunology Laboratory</td>
</tr>
</tbody>
</table>

C. Upper-Division Biology Electives:

Select six of the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI E124</td>
<td>Infectious Disease Dynamics</td>
</tr>
<tr>
<td>BIO SCI E176</td>
<td>Evolution of Infectious Disease</td>
</tr>
<tr>
<td>BIO SCI M119</td>
<td>Advanced Topics in Immunology</td>
</tr>
<tr>
<td>BIO SCI M120</td>
<td>Signal Transduction in Mammalian Cells</td>
</tr>
<tr>
<td>BIO SCI M124B</td>
<td>Viral Pathogenesis and Immunity</td>
</tr>
<tr>
<td>BIO SCI M125</td>
<td>Molecular Biology of Cancer</td>
</tr>
<tr>
<td>BIO SCI M137</td>
<td>Microbial Genetics</td>
</tr>
<tr>
<td>BIO SCI M143</td>
<td>Human Parasitology</td>
</tr>
<tr>
<td>MOL BIO 205</td>
<td>Molecular Virology</td>
</tr>
</tbody>
</table>

or from Alternatives:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI D103</td>
<td>Cell Biology</td>
</tr>
<tr>
<td>BIO SCI D137</td>
<td>Eukaryotic and Human Genetics</td>
</tr>
<tr>
<td>BIO SCI M114</td>
<td>Advanced Biochemistry</td>
</tr>
<tr>
<td>BIO SCI M116</td>
<td>Advanced Molecular Biology</td>
</tr>
</tbody>
</table>
### Requirements for the Specialization in Immunology

**A. Required Major Courses:**
- BIO SCI M121: Immunology with Hematology
- BIO SCI M122: General Microbiology
- BIO SCI M124A: Virology

**B. Upper-Division Laboratories:**
- BIO SCI M116L- M127L: Molecular Biology Laboratory and Virology and Immunology Laboratory

**C. Upper-Division Biology Electives:**
Select six of the following:
- **Recommended:**
  - BIO SCI M119: Advanced Topics in Immunology
  - BIO SCI M120: Signal Transduction in Mammalian Cells
  - BIO SCI M124B: Viral Pathogenesis and Immunity
  - BIO SCI M125: Molecular Biology of Cancer
- or from Alternatives:
  - BIO SCI D103: Cell Biology
  - BIO SCI D137: Eukaryotic and Human Genetics
  - BIO SCI M114: Advanced Biochemistry
  - BIO SCI M116: Advanced Molecular Biology
  - BIO SCI M137: Microbial Genetics
  - BIO SCI M144: Cell Organelles and Membranes

### Requirements for the Specialization in Microbiology

**A. Required Major Courses:**
- BIO SCI M121: Immunology with Hematology
- BIO SCI M122: General Microbiology
- BIO SCI M124A: Virology

**B. Upper-Division Laboratories:**
- BIO SCI M116L- M118L: Molecular Biology Laboratory and Experimental Microbiology Laboratory

**C. Upper-Division Biology Electives:**
Select six of the following:
- **Recommended:**
  - BIO SCI E124: Infectious Disease Dynamics
  - BIO SCI E176: Evolution of Infectious Disease
  - BIO SCI M137: Microbial Genetics
  - BIO SCI M143: Human Parasitology
- or from Alternatives:
  - BIO SCI D103: Cell Biology
  - BIO SCI D137: Eukaryotic and Human Genetics
  - BIO SCI M114: Advanced Biochemistry
  - BIO SCI M116: Advanced Molecular Biology
  - BIO SCI M144: Cell Organelles and Membranes

### Requirements for the Specialization in Virology

**A. Required Major Courses:**
- BIO SCI M121: Immunology with Hematology
- BIO SCI M122: General Microbiology
- BIO SCI M124A: Virology

**B. Upper-Division Laboratories:**
- BIO SCI M116L- M127L: Molecular Biology Laboratory and Virology and Immunology Laboratory

**C. Upper-Division Biology Electives:**
Select six of the following:
- **Recommended:**
  - BIO SCI M119: Advanced Topics in Immunology
  - BIO SCI M120: Signal Transduction in Mammalian Cells
  - BIO SCI M124B: Viral Pathogenesis and Immunity
  - BIO SCI M125: Molecular Biology of Cancer
- or from Alternatives:
  - BIO SCI D103: Cell Biology
  - BIO SCI D137: Eukaryotic and Human Genetics
  - BIO SCI M114: Advanced Biochemistry
  - BIO SCI M116: Advanced Molecular Biology
  - BIO SCI M144: Cell Organelles and Membranes
Select six of the following:

**Recommended:**

- BIO SCI E124  Infectious Disease Dynamics
- BIO SCI M120  Signal Transduction in Mammalian Cells
- BIO SCI M124B  Viral Pathogenesis and Immunity
- BIO SCI M125 or MOL BIO 205  Molecular Biology of Cancer
- BIO SCI M124B  Molecular Virology

**or from Alternatives:**

- BIO SCI D103  Cell Biology
- BIO SCI D137  Eukaryotic and Human Genetics
- BIO SCI M114  Advanced Biochemistry
- BIO SCI M116  Advanced Molecular Biology
- BIO SCI M137  Microbial Genetics
- BIO SCI M144  Cell Organelles and Membranes

**NOTE:** Within the Microbiology and Immunology major, only one specialization can be awarded.

**Application Process to Declare the Major:** The major in Microbiology and Immunology is open to junior- and senior-level students only. Applications to declare the major can be made at any time, but typically in the spring of the sophomore year. Review of applications submitted at that time and selection to the major by the Microbiology and Immunology Faculty Board is completed during the summer. Information can also be found at the UCI Change of Major Criteria website (http://www.changeofmajor.uci.edu). Double majors within the Francisco J. Ayala School of Biological Sciences or with Public Health Sciences, Biomedical Engineering: Premedical, Nursing Science, or Pharmaceutical Sciences are not permitted.

**Sample Program — Microbiology and Immunology**

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI 93</td>
<td>BIO SCI 94</td>
<td>CHEM 1C - 1LC</td>
<td></td>
</tr>
<tr>
<td>CHEM 1A</td>
<td>CHEM 1B</td>
<td>General Ed.</td>
<td></td>
</tr>
<tr>
<td>General Ed.</td>
<td>General Ed.</td>
<td>General Ed.</td>
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</tr>
<tr>
<td>BIO SCI 2A</td>
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<table>
<thead>
<tr>
<th>Sophomore</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
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</thead>
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<tr>
<td>BIO SCI 97</td>
<td>BIO SCI 98</td>
<td>BIO SCI 99</td>
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</tr>
<tr>
<td>CHEM 51A</td>
<td>CHEM 51B - 51LB</td>
<td>CHEM 51C - 51LC</td>
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</tr>
<tr>
<td>CHEM 1LD</td>
<td>General Ed.</td>
<td>General Ed.</td>
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<tr>
<td>MATH 2A</td>
<td>MATH 2B</td>
<td>MATH 2D, 3A, STATS 7, or STATS 8</td>
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</tr>
<tr>
<td>BIO SCI 194S</td>
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<table>
<thead>
<tr>
<th>Junior</th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
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</thead>
<tbody>
<tr>
<td>PHYSICS 3A</td>
<td>PHYSICS 3B - 3LB</td>
<td>PHYSICS 3C - 3LC</td>
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<tr>
<td>BIO SCI M124A</td>
<td>BIO SCI M121</td>
<td>BIO SCI M122</td>
<td></td>
</tr>
<tr>
<td>BIO SCI 100</td>
<td>BIO SCI M116L</td>
<td>GE or U-D Lab</td>
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</tr>
<tr>
<td>BIO SCI 199</td>
<td>BIO SCI 199</td>
<td>BIO SCI 199</td>
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<table>
<thead>
<tr>
<th>Senior</th>
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<tr>
<td>U-D Biology Elective</td>
<td>U-D Biology Elective</td>
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<tr>
<td>U-D Biology Elective</td>
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<td>U-D Biology Elective</td>
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</tr>
<tr>
<td>BIO SCI 199</td>
<td>BIO SCI 199</td>
<td>BIO SCI 199</td>
<td></td>
</tr>
</tbody>
</table>

1 CHEM H52A-CHEM H52B-CHEM H52C, CHEM H52LA-CHEM H52LB may be taken instead of CHEM 51A-CHEM 51B-CHEM 51C, CHEM 51LB-CHEM 51LC.

**Undergraduate Major in Neurobiology**

The Neurobiology major is designed to teach students how neurobiologists apply cellular, molecular, systems, and behavioral analyses in understanding how the nervous system works. The hallmark of the major is a year-long, in-depth exploration of the intellectual tools used to create, advance, and disseminate knowledge about the nervous system. Through neurobiology satellite courses, students acquire advanced factual knowledge about
neurobiology. In addition, Neurobiology majors may choose to participate in research through BIO SCI 199, where they will learn technical skills and receive mentoring from faculty members.

Students completing the Neurobiology major will be well qualified for admission to graduate or professional schools in preparation for careers in biological research, medicine, dentistry, veterinary medicine, nursing, and other related fields. Even without additional education, they will be competitive for positions in the pharmaceutical industry, the health care delivery industry, or in medically or biologically related technologies. The major also provides valuable preparation for students interested in entering other disciplines that increasingly interface with biology and biotechnology, such as law, business administration, and government policy. Additionally, the major provides excellent preparation for students who wish to become high school science teachers.

Requirements for the B.S. Degree in Neurobiology

All students must meet the University Requirements.

All students must meet the School Requirements.

Major Requirements

A. Upper-Division Core:

BIO SCI N110  Neurobiology and Behavior

and select one of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI D103</td>
<td>Cell Biology</td>
</tr>
<tr>
<td>BIO SCI D104</td>
<td>Developmental Biology</td>
</tr>
<tr>
<td>BIO SCI E109</td>
<td>Human Physiology</td>
</tr>
</tbody>
</table>

B. Required Major Courses:

BIO SCI N115A- N115B  Advanced Neurobiology I and Advanced Neurobiology II

C. Upper-Division Laboratories:

BIO SCI N113L  Neurobiology Laboratory

and select two of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>BIO SCI D111L</td>
<td>Developmental and Cell Biology Laboratory</td>
</tr>
<tr>
<td>BIO SCI E106L</td>
<td>Habitats and Organisms</td>
</tr>
<tr>
<td>BIO SCI E112L</td>
<td>Physiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI E115L</td>
<td>Evolution Laboratory</td>
</tr>
<tr>
<td>BIO SCI E131L</td>
<td>Image Analysis in Biological Research</td>
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<tr>
<td>BIO SCI E140L</td>
<td>Evolution and the Environment Laboratory</td>
</tr>
<tr>
<td>BIO SCI E161L</td>
<td>Biology of Birds Lab</td>
</tr>
<tr>
<td>BIO SCI E166L</td>
<td>Field Biology</td>
</tr>
<tr>
<td>BIO SCI E172L</td>
<td>Plant Systematics Laboratory</td>
</tr>
<tr>
<td>BIO SCI E179L</td>
<td>Field Freshwater Ecology</td>
</tr>
<tr>
<td>BIO SCI M114L</td>
<td>Biochemistry Laboratory</td>
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<tr>
<td>BIO SCI M116L</td>
<td>Molecular Biology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M118L</td>
<td>Experimental Microbiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M121L</td>
<td>Advanced Immunology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M122L</td>
<td>Advanced Microbiology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M124L</td>
<td>Virus Engineering Laboratory</td>
</tr>
<tr>
<td>BIO SCI M127L</td>
<td>Virology and Immunology Laboratory</td>
</tr>
<tr>
<td>BIO SCI M130L</td>
<td>Advanced Molecular Lab Techniques</td>
</tr>
</tbody>
</table>

One of these two laboratories can be satisfied by completion of Excellence in Research in the Biological Sciences.

D. Upper-Division Biology Electives:

Select three of the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI N119–N190</td>
<td></td>
</tr>
</tbody>
</table>

and select one four-unit course from the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI D103–D190</td>
<td>E106–E190, M114–M190, N110–N190</td>
</tr>
<tr>
<td>CHEM 131A</td>
<td>Quantum Principles</td>
</tr>
<tr>
<td>CHEM 131B</td>
<td>Molecular Structure and Elementary Statistical Mechanics</td>
</tr>
<tr>
<td>CHEM 131C</td>
<td>Thermodynamics and Chemical Dynamics</td>
</tr>
<tr>
<td>PHYSICS 147A</td>
<td>Principles of Imaging</td>
</tr>
</tbody>
</table>
No course may be used to satisfy more than one requirement.

E. Honors Track of the Neurobiology Major: BIO SCI H195 in the area of neurobiology and Excellence in Research in the Biological Sciences - presenting neurobiology related research. ¹

¹ Requirements to enter the Honors Track: A 3.3 or better average GPA in BIO SCI N115A-BIO SCI N115B and a 3.0 or better average GPA in all required biology courses.

If the number of eligible students who apply for the Honors Track exceeds the number that can be accommodated in the neurobiology related H195, the department will try to open an additional section. If this is not feasible, the Neurobiology Major Faculty Advisory Committee will select the top applicants, based mainly on the students’ BIO SCI N115A-BIO SCI N115B grades and biology GPA.

Application Process to Declare the Major: The major in Neurobiology is open to junior- and senior-level students only. Applications to declare the major can be made at any time, but typically in the spring of the sophomore year. Review of applications submitted at that time and selection to the major by the Neurobiology Faculty Board is completed during the summer. Information can also be found at the http://www.changeofmajor.uci.edu. Double majors within the Francisco J. Ayala School of Biological Sciences or with Public Health Sciences, Biomedical Engineering: Premedical, Nursing Science, or Pharmaceutical Sciences are not permitted.

Sample Program — Neurobiology

Freshman

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Winter</th>
<th>Spring</th>
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<tbody>
<tr>
<td>Fall</td>
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</tr>
<tr>
<td>BIO SCI 93</td>
<td>BIO SCI 94</td>
<td>CHEM 1C- 1LC</td>
</tr>
<tr>
<td>CHEM 1A</td>
<td>CHEM 1B</td>
<td>HUMAN 1C</td>
</tr>
<tr>
<td>HUMAN 1A¹</td>
<td>HUMAN 1B</td>
<td>HUMAN 1CS</td>
</tr>
<tr>
<td>HUMAN 1AS¹</td>
<td>HUMAN 1BS</td>
<td>MATH 2A</td>
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<td>BIO SCI 2A</td>
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</table>

Sophomore

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<thead>
<tr>
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<th>Winter</th>
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<tbody>
<tr>
<td>Fall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIO SCI 97</td>
<td>BIO SCI 98</td>
<td>BIO SCI 99</td>
</tr>
<tr>
<td>CHEM 1LD</td>
<td>STATS 7, 8, MATH 2D, or MATH 3A</td>
<td>BIO SCI N110</td>
</tr>
<tr>
<td>CHEM 51A²</td>
<td>CHEM 51B- 51LB</td>
<td>CHEM 51C- 51LC</td>
</tr>
<tr>
<td>BI SCI 194S</td>
<td></td>
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</table>

Junior

<table>
<thead>
<tr>
<th>Junior</th>
<th>Winter</th>
<th>Spring</th>
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<tbody>
<tr>
<td>Fall</td>
<td></td>
<td></td>
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<tr>
<td>Bio. Sci. Elective</td>
<td>BIO SCI N113L</td>
<td>PHYSICS 3C- 3LC</td>
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<td>BIO SCI 100</td>
<td>PHYSICS 3B- 3LB</td>
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<tr>
<td>PHYSICS 3A</td>
<td>Research/Elective</td>
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<tr>
<td>Senior</td>
<td>Winter</td>
<td>Spring</td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td></td>
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<tr>
<td>Research/Elective</td>
<td>Bio. Sci. Elective</td>
<td>Research/Elective</td>
</tr>
<tr>
<td>General Ed./Elective</td>
<td>General Ed./Elective</td>
<td>General Ed./Elective</td>
</tr>
</tbody>
</table>

¹ Students have the option of taking HUMAN 1A and HUMAN 1AS or lower-division writing courses.

² CHEM H52A-CHEM H52B-CHEM H52C, CHEM H52LA-CHEM H52LB may be taken instead of CHEM 51A-CHEM 51B-CHEM 51C, CHEM 51LB-CHEM 51LC.

Requirements for the Minor in Biological Sciences

Nine courses are required, no more than two of which may be taken on a Pass/Not Pass basis:

A. Select three of the following: ¹

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO SCI 93</td>
<td>From DNA to Organisms</td>
</tr>
<tr>
<td>BIO SCI 94</td>
<td>From Organisms to Ecosystems</td>
</tr>
<tr>
<td>BIO SCI 97</td>
<td>Genetics</td>
</tr>
<tr>
<td>BIO SCI 98</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>BIO SCI 99</td>
<td>Molecular Biology</td>
</tr>
</tbody>
</table>

B. Select six of the following: ²

Three- or four-unit courses selected from BIO SCI 5–H90 (excluding 14 and 46), 93–99, and D103–D190, E106–E190, M114–M190, N110–N190.
Prerequisites are strictly enforced. Exceptions may be made for some majors that accept the above courses for degree requirements. Consult with the Biological Sciences Student Affairs Office or the academic counseling office of the major.

Three courses must be upper-division. Prerequisites are strictly enforced. (Courses used to satisfy group A may not also be used to satisfy group B.)

Residence requirement for the minor: A minimum of six courses required for the minor must be completed at UCI. Approved courses taken in the Education Abroad Program are considered to be in-residence courses.

NOTE: Students in any of the majors within the Francisco J. Ayala School of Biological Sciences or students majoring in Public Health Sciences, Biomedical Engineering: Premedical, Nursing Science, or Pharmaceutical Sciences may not minor in Biological Sciences.

On This Page:

- Graduate Study in Biological Sciences
- Master of Science
- Doctor of Philosophy
- Master of Science with a Concentration in Biotechnology
- Master of Science in Biotechnology Management (MSBTM)
- Master of Science in Biological Sciences and Educational Media Design
- Interdisciplinary Graduate Programs
  - Graduate Program in Cellular and Molecular Biosciences
  - Graduate Program in Mathematical and Computer Biology
  - Interdepartmental Neuroscience Program

Graduate Study in Biological Sciences

The Francisco J. Ayala School of Biological Sciences offers graduate study in a wide variety of fields ranging across the spectrum of the biological sciences. The four Departments of the Francisco J. Ayala School of Biological Sciences (Developmental and Cell Biology, Ecology and Evolutionary Biology, Molecular Biology and Biochemistry, and Neurobiology and Behavior) offer concentrations of study under the Ph.D. degree administered by the Francisco J. Ayala School of Biological Sciences. Most graduate students are admitted to the Doctor of Philosophy (Ph.D.) degree program. Additionally, the master’s program in Biotechnology (M.S. degree in Biological Sciences), the M.S. degree in Biological Sciences and Educational Media Design, the M.S. degree in Biotechnology Management, and the master’s program in any of the four departments (M.S. degree in Biological Sciences) are offered. Each department has a graduate advisor whom students may consult for additional details of the individual programs. Several interdisciplinary graduate programs are also available: Graduate Program in Cellular and Molecular Biosciences, Graduate Program in Mathematical and Computational Biology, and Interdepartmental Neuroscience Program.

The department or program evaluates applications for admission to graduate study based on letters of recommendation, Graduate Record Examination scores, grades, research experience, and other relevant qualifications of the applicant. Candidates for graduate admission are urged to consult the particular department or program whose faculty and expertise best fit their interests and background.

Master of Science and Doctor of Philosophy in the Biological Sciences

The Francisco J. Ayala School of Biological Sciences offers both the Master of Science and Doctor of Philosophy, although emphasis at the graduate level is placed on the Ph.D. programs. Most training takes place within one of the departments, although full facilities and curricular offerings are available to all graduate students in all departments of the Biological Sciences. Interdisciplinary study and research are encouraged.

Students are expected to maintain a B average at all times. The normative time to degree is two years for the master’s degree and five years for the doctoral degree. A master’s degree is not a prerequisite for the Ph.D. degree.

Students plan their academic program in consultation with the graduate advisor or a faculty committee. Faculty advisors may be changed to meet the needs and interests of the student. In addition, it is possible for students to transfer to another program in the School, subject to the approval of the dean of Graduate Studies, and acceptance into that program. Students are encouraged to consult with faculty members with regard to their research and academic interests.

During their graduate training, all doctoral students are required to serve at least two quarters as a 50-percent teaching assistant under the direction of laboratory coordinators or faculty. Advanced graduate students may work closely with faculty in the planning and execution of the teaching program. The amount and nature of the teaching experience varies with the department.

Master of Science

The Master of Science degree may be completed by submission of a research thesis (plan I) or by course work and a comprehensive examination (plan II).
Plan I: Thesis Plan. The student is required to complete at least four didactic graduate courses (16 units) offered by the department, and elective course work with an additional eight units of graduate or upper-division undergraduate course work. In addition, the student will typically take additional seminar courses during the graduate study. Students in the M.S. program may be employed as teaching assistants, but units earned through enrollment in University Teaching (399) may not be counted toward degree completion. The student engages in thesis research with a faculty thesis advisor, and will prepare and submit a thesis to the thesis committee. The final examination is an oral presentation of the thesis to the committee. The normative time to degree is two years for the thesis M.S. degree.

Plan II: Comprehensive Examination Plan. The plan II M.S. degree is awarded based on completion of at least 36 units of course work and satisfactory completion of a comprehensive examination. The student is required to complete at least 16 units (four courses) of didactic graduate course work offered by the department. In addition, the student will take up to 12 units of research. An additional eight units or more of elective course work will be completed from other graduate courses offered by the department. A maximum of four units of upper-division undergraduate courses may be included in the program with the approval of the associate dean for Graduate Studies. Students in the M.S. program may be employed as teaching assistants, but units earned through enrollment in University Teaching (399) may not be counted toward degree completion. The comprehensive exam will be administered by a committee of at least three departmental faculty, and may include written and oral sections. The comprehensive examination format will include presentation of research or a capstone project and may include additional sections such as a research proposal, presentation of a project, critical analysis, or other components. The normative time to degree is two years for the M.S. degree by comprehensive examination.

Doctor of Philosophy

Comprehensive Examination-First Year. Some departments and graduate programs require a comprehensive examination that is generally taken at the end of the first year of graduate study.

Advancement to Candidacy Exam. The advancement to candidacy examination is taken in the third year of graduate study. The student will prepare a written research proposal based on a federal granting agency format, and the proposal will be submitted to the advancement committee. The student will present the research proposal to a committee of five faculty members. At the time of advancement to candidacy, the student is expected to have identified an important and tractable dissertation topic, and to have demonstrated the technical and intellectual skills to complete doctoral thesis research.

Once the advancement to candidacy examination is completed, the student is expected to complete the doctoral degree within three years. The student must submit a dissertation on their research and defend the thesis in an oral examination during the final year of graduate study. The normative time for completion of the Ph.D. is five years, and the maximum time permitted is seven years.

Graduate student status or consent of instructor is a prerequisite for all 200–299 courses.

Master of Science with a Concentration in Biotechnology

Department of Molecular Biology and Biochemistry

Michael G. Cumsky, Director
3205 McGaugh Hall
949-824-6034
http://www.bio.uci.edu/
morgano@uci.edu

The field of biotechnology has developed explosively since the discovery of gene cloning and sequencing methods in the mid-1970s. The field is now represented by many active and successful companies who share an intense demand for well-trained people with up-to-date research skills in the manipulation of nucleic acids, proteins, immunological reagents, and pathogenic organisms. The program in Biotechnology features two tracks leading to an M.S. degree in Biological Sciences. The first is the traditional program, and the second, which takes advantage of a defined area of campus research strength, provides an emphasis in stem cell biology. Both tracks incorporate extensive training from both teaching laboratories and actual research settings (individual faculty laboratories). Focus is placed on techniques relevant to industry and seminar exposure to the nature of industry. It is designed to train students to enter the field of biotechnology as skilled laboratory practitioners. Emphasis is placed on learning state-of-the-art technology in protein isolation and characterization, animal and microbial cell culture, virology, immunology, and/or stem cell biology. Students are trained in experimental rationales for solving actual research problems and are encouraged to take summer internships in industry between the first and second year of their studies.

The Department of Molecular Biology and Biochemistry evaluates applicants to the program on the basis of grades, letters of recommendation, GRE scores, and other relevant qualifications. Applicants should have successfully completed a B.S. degree or equivalent. Courses should include general chemistry with laboratory, calculus, physics, organic chemistry, genetics, biochemistry, molecular biology, microbiology, immunology, and virology, as well as laboratory courses in biochemistry, molecular biology, microbiology, and either animal virology or immunology. Enrollment in the stem cell biology emphasis is limited to eight continuing students per year. Biotechnology graduate students interested in this track apply for admission during the winter quarter of their first year in the program.

The traditional program emphasizes training in laboratory and research environments. First-year students are required to enroll in a series of laboratory courses:
Some of the distinctive features of the MSBTM program include the following:

- Students enrolled in the stem cell biology emphasis take the same number of laboratory and lecture courses as those in the traditional track. However, in the spring quarter of their first year they must enroll in the stem cell laboratory (taught at the Stem Cell Research Core Facility), and their electives must include the following courses, if offered: Stem Cell Policy (M&MG 230), Stem Cell Biology (DEV BIO 245), and Clinical Aspects of Stem Cells (DEV BIO 203B, when offered). In addition, their individual research must be conducted in the laboratory of a faculty member utilizing stem cells.

- Students will learn to think as a business manager by solving product development strategies associated with effective managerial action. The course is structured as a full-time, in-residence intensive;

- Advanced training in biotechnology through course work and an eight-unit teaching laboratory;

- A research component whereby students will engage in research with a faculty member in either the Francisco J. Ayala School of Biological Sciences or the Department of Biomedical Engineering (requests to perform research in labs outside of Biological Sciences or Biomedical Engineering will be considered on a case-by-case basis). This research component is considered to be important for careers in the biotechnology industry and makes this program unique worldwide;

- An Intensive course, Business and Management in the 21st Century (MGMT MBA 200), which presents fundamental concepts, tools, and solutions from management to initiate students into the concrete challenges that managers in high-performing organizations typically confront. Students will be introduced to the pedagogical methods of case analysis, group problem solving, and group presentations as a means of developing the skills and strategies associated with effective managerial action. The course is structured as a full-time, in-residence intensive;

- An experiential learning component wherein student teams, under the guidance of The Paul Merage School of Business and Department of Molecular Biology and Biochemistry professors, act as a consulting team which works with managers of biotechnology or biological science-based companies on innovative solutions to current problems faced by the companies;

- A business plan component wherein students from biosciences and management prepare a formal business plan for an Entrepreneurship or New Venture Management course;

- A new capstone course taught in the spring quarter of the second year by faculty in both Biological Sciences and The Paul Merage School of Business. The cross-listed course, Biotech Management (MOL BIO 253)/Biotech Management (MGMT MBA 293) will integrate the program’s two-year curriculum and provide a format for the required comprehensive exam. The curriculum will address a number of management issues in the biotech industry including finance, product development, pharmaceuticals, project management, regulatory affairs, and ethics. Guest lecturers from the biotech industry will also be invited to talk about both the scientific and management sides of their companies;
• “Proseminar” courses in the first year that provides students with information and practical skills for success in the program and career planning.

Admissions

Applicants will apply directly to the Graduate Division for the MSBTM program beginning each fall. The program uses rolling admission deadlines. The priority deadline is January 15; applications received by this date are read first, and we begin filling next fall's class from this group. March 15 is the normal deadline; the remainder of the class is filled from these applicants. If the class is not full after review of the March 15 applicants, we will accept additional applications until June 1. Prerequisite requirements will be the same as those for the Graduate Program in Biotechnology, which include a B.A. or B.S. degree in biological sciences or related discipline and several specific elective and laboratory courses. Admission to graduate standing in MB&B is generally accorded to those possessing a B.S. degree in biological sciences or an allied field obtained with an acceptable level of scholarship from an institution of recognized standing. Those seeking admission without the prerequisite scholarship record may, in some cases, undertake remedial work; if such work is completed at the stipulated academic level, the applicant will be considered for admission. Those admitted from an allied field may be required to take supplementary upper-division courses in basic engineering subjects. The Graduate Record Examination (GRE) General Test is required of all applicants.

Foreign students will be required to submit a TOEFL score and occasionally a TSE score. Applicants from India must submit one of the following in order to be eligible for graduate studies consideration: a continuous four-year degree from an accredited university, college, or institution, or a completed three-year bachelor’s accompanied with a completed two-year master’s degree. The combination of 3+2 would be the equivalent of the U.S. bachelor’s degree. The MSBTM program does not accept a straight three-year bachelor’s degree, nor does it accept a one-year completion of the two-year master’s degree in the 3+2 combination.

Applicants will be evaluated on their prior academic record and their potential for management and leadership as demonstrated in the submitted application materials (university’s transcripts, GRE test scores, letters of recommendation, applicable work experience, a Statement of Purpose, and an essay). In addition, there will be an interview by admissions counselors from The Paul Merage School of Business.

Course Work and Examination Requirements

M.S. Plan II: Seventeen required courses, a minimum of 77 units, a zero-unit Proseminar sequence in the first year (defined below), and a comprehensive examination which will be administered during the jointly taught capstone course in the spring quarter of the second year.

Required and Recommended Courses, Business: A total of nine courses adding up to 36 units. These include the Intensive Business and Management in the 21st Century (MGMT MBA 200), Experiential Learning (MGMT MBA 298), or New Venture Management (MGMT MBA 213), and at least six courses from the Paul Merage School of Business, of which:

Three courses must be selected from the following five courses: Management Science (MGMT MBA 201B), Organizational Behavior for Management (MGMT MBA 202), Financial Reporting for Management (MGMT MBA 203A), Marketing Management (MGMT MBA 205), Managerial Finance (MGMT MBA 209A), and categorized as required courses;

Two courses must be selected from the following three courses: US Health Policy (MGMT MBA 264), Supply Chain Management (MGMT MBA 285), Business Law (MGMT MBA 292), and categorized as restricted elective courses; and

One additional elective course of the student’s choosing.

Required and Recommended Courses, Biotechnology: A total of seven courses adding up to 36 units. These include:

Two core biological science courses, Nucleic Acid Structure and Function (MOL BIO 203) and Protein Structure and Function (MOL BIO 204);

Two additional graduate-level elective courses in biological sciences or biomedical engineering;

One teaching laboratory course focusing on essential methods in biotechnology, Biotechnology Management Laboratory (MOL BIO 252L); and

Two quarters of research (four units in winter quarter of the second year and eight units in spring quarter of the second year) whereby students will engage in independent research with a faculty member of their choosing in the School of Biological Sciences or Department of Biomedical Engineering (requests to perform research in labs outside of Biological Sciences or Biomedical Engineering will be considered on a case by case basis).

Proseminar Course (Year One)

This three-quarter course, MBA Proseminar (MGMT MBA 211), provides students with information and practical skills for success in the program and for career planning. The goal is to help clarify goals and develop skills and techniques to successfully manage the job search process for employment upon graduation and throughout one's career. This will be accomplished through workshops, presentations, webinars, and meetings with career counselors. Topics include resume writing, job interview coaching, company hiring practices, and career advice and counseling.

Capstone Course (Year Two)

(Biotech Management (MOL BIO 253)/Biotech Management (MGMT MBA 293), five units), jointly taught by Biological Sciences and Business School faculty, is designed to integrate the program’s two-year curriculum and provide a format for the required comprehensive exam. The curriculum will address a number of management issues in the biotech industry including finance, product development, pharmaceuticals, project management,
regulatory affairs, and ethics. Guest lecturers from the biotech industry will also be invited to talk about both the scientific and management sides of their companies.

Master of Science in Biological Sciences and Educational Media Design

Brad Hughes, Director
301 Steinhaus Hall
949-824-2359
bhughes@uci.edu

Program Objectives and Student Eligibility
To meet the increasingly complex challenges facing science and education, highly trained professionals with advanced scientific knowledge and pedagogical techniques coupled with state-of-the-art media design skills will be the science education leaders of the future. The Master of Science in Biological Sciences and Educational Media Design establishes an intensive pathway for training those innovative leaders. The program can be completed flexibly within one or two years of study, in as little as nine months of full-time study, or over two years of part-time study. In order to make the program accessible to working professionals, courses will be available during the academic year in the early evening and during the regular summer session. With the convenience of evening and summer course schedules, the program is tailored to suit working science educators.

Program candidates will typically possess the qualifications of a teaching credential and a B.S. in Biological Sciences or comparable degree, and have obtained a 3.0 or better GPA. Students with degrees in other areas will be considered if they have substantial course work in biology, chemistry, mathematics, and physics that is comparable to the degree requirements for a B.S. in Biological Sciences from UCI. Applicants possessing different prerequisite qualifications may potentially be considered for admission by approval of the program director with consideration of experience and/or additional course work, on an individual case basis.

Curriculum Description
The program offers an integrative interdisciplinary structure with a curriculum that includes advanced academic biological sciences course work electives, individually selected from upper-division and graduate-level schoolwide offerings. Students also choose from external field experience, research lab experience, or a graduate course in the School of Education. A special graduate-level integrative biological science course, Experimental Evolution in Biology and Education, is part of the required core courses. The four additional core courses comprise a blend of advanced training in the field of science education and leadership, media production technologies, and educational media design. The biological and educational course work are integrated through the productive synthesis of pedagogical methods, science content, and media design, culminating in a capstone project of biological science educational media that is presented and defended in the final quarter of study. Students are encouraged to serve as teaching assistants during their program; however, course units earned for University Teaching (399) will not count as units for degree completion.

Required and Elective Course Work
The M.S. program requires a minimum of 36 quarter units in approved courses, at least 24 of which must be from graduate-level courses in the 200 series or higher. Four graduate-level core courses (16 units) in science education media design are required for the M.S. degree including the following:

1. Advanced Pedagogical Design and Educational Science Media Production (four units, fall, lecture);
2. Directed Research Specialization and Project Development (four units, fall, lab);
3. Directed Educational Media Project Production (four units, winter, lab); and
4. Project Presentations and Science Education Leadership (four units, spring, lecture/seminar).

Three academic courses (12 units) in biological sciences are also required, including the required core graduate course Experimental Evolution in Biology and Education (four units, winter, lecture/seminar). The remaining eight academic course units may include graduate-level courses offered by the School of Biological Sciences (lecture or lab, approval of the departmental instructor and the program director are required), or upper-division undergraduate courses offered by the School of Biological Sciences (lecture or lab, approval of the program director is required).

Another eight units of electives from any of the following options must also be completed (approval of the program director is required), including:

1. Independent laboratory research (up to eight units, e.g., DEV BIO 200A);
2. Independent field research (up to eight units, e.g., ECO EVO 200A);
3. Graduate course work in the School of Education (maximum of four units);
4. Upper-division courses offered by the School of Biological Sciences (maximum of four units, lecture or lab); and
5. Graduate-level courses offered by the School of Biological Sciences (up to eight units, lecture or lab).
Capstone Project for Degree Completion

The written documentation, multimedia product, and oral presentation of the educational media capstone project will serve as the comprehensive examination for completion of the M.S. degree in Biological Sciences and Educational Media Design. The centerpiece of the capstone project is the educational media product, which uses modern multimedia tools to provide compelling educational content that links conceptually to the biological science course work content. The methodological design of the educational media demonstrates the student's pedagogical skills, as well as technical facility with media development tools. The scope of the project is set to a reasonable size and challenge range, both worthy of the master's degree and also realistically attainable. Projects may be developed using a modular production design in consultation with the program director, so that various elements are functional, while others are descriptively simulated, to efficiently showcase the educational media product design effectively without unreasonably high production efforts.

The educational media products are accompanied by a well-written documentation package. A requirement list and format for the project documentation package is provided early in the program, and includes such elements as pedagogical rationale for product design referenced to pedagogical course work, California State content standards addressed, lesson plans, bibliographic references, background content information referenced to biological science course work, user manual instructions, assessment tools, media overview linked to media design and production course work, and advertisement of product features. All projects will be required to address National or State standards, except by approval of the program director, for projects that deal with higher education or public educational foci.

Presentations of the projects occur during class sessions via multimedia colloquia style talks for instructor and peer review. Presentations emulate in-service training for end users, including comprehensive integrated descriptions of the project's educational media features and documentation package. This constructive process includes extensive peer evaluation, revisionary responses, and discussion participation. Exemplary capstone projects may be exhibited/presented at the annual UCI Media Arts in Science Symposia (MASS), currently in development.

Courses in Biological Sciences and Educational Media Design

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>BSEMD 200</td>
<td>Individual Research</td>
</tr>
<tr>
<td>BSEMD 211</td>
<td>Advanced Pedagogical Design and Educational Science Media Production</td>
</tr>
<tr>
<td>BSEMD 212</td>
<td>Directed Research Specialization and Project Development</td>
</tr>
<tr>
<td>BSEMD 213</td>
<td>Directed Educational Media Project Production</td>
</tr>
<tr>
<td>BSEMD 214</td>
<td>Project Presentations and Science Education Leadership</td>
</tr>
<tr>
<td>BSEMD 220</td>
<td>Experimental Evolution in Biology and Education</td>
</tr>
<tr>
<td>BSEMD 299</td>
<td>Independent Study</td>
</tr>
</tbody>
</table>

Interdisciplinary Graduate Programs

The School is structured in a manner that encourages an interdisciplinary approach to scientific problems. Interaction and cooperative efforts across traditional institutional boundaries are especially evident in the School's participation in various organized research units (described in the Office of Research section) and in the interdepartmental/interschool graduate programs described below.

Graduate Program in Cellular and Molecular Biosciences

Melanie Cocco, Director

Administrative Contact Information: Renee Frigo
4141 Natural Sciences II
949-824-8145
http://cmb.uci.edu

The combined graduate program in Cellular and Molecular Biosciences (CMB) provides the first year of instruction for graduate students entering Ph.D. programs in six departments within the Francisco J. Ayala School of Biological Sciences and the School of Medicine. Applicants should have significant laboratory experience and be well prepared in biochemistry, molecular biology, cell biology, and genetics with appropriate course work in organic chemistry, calculus, and physics.

During the first year, students will select one of five focus areas: “Immunology and Microbiology”, “Cancer and Cell Biology”, “Structural Biology, Biochemistry, and Biophysics”, “Developmental and Stem Cell Biology” or “Genetics, Epigenetics and Genomics.” Students will select three didactic courses, one each quarter, from a menu of course options recommended for their focus area. Students with more general interests will be allowed to substitute courses to gain knowledge in different areas of biomedical science. Furthermore, any student may switch focus areas during the first year. Changes to coursework or Focus Area can be achieved by simple petition to the CMB director. During the first year the students also complete three required 2-unit S/U courses (Ph.D. Fundamentals, Biomedical Research Methods, and Responsible Conduct of Research) that develop knowledge and skills not necessarily covered in the didactic courses. Students may take additional elective courses relevant to their area of specialization although this is not encouraged. Each Focus Area recommends elective courses for students in years 2 or later, to be taken after transfer to a departmental Ph.D. program.

The students also undertake introductory research in at least two laboratories during their first year. Students can select a laboratory rotation from over 100 faculty laboratories in the departments of Biological Chemistry, Developmental and Cell Biology, Microbiology and Molecular Genetics, Molecular Biology and Biochemistry, Pathology and Laboratory Medicine, and Physiology and Biophysics. Each faculty member's area of research is described on
the department websites. Faculty also are associated with research areas that span departments, as shown on the CMB Web site. The year culminates in a comprehensive preliminary examination and evaluation.

At the end of the first academic year, students will select a thesis advisor in one of the departments. Students who select a thesis advisor in the Francisco J. Ayala School of Biological Sciences (Department of Developmental and Cell Biology or Molecular Biology and Biochemistry) will complete the doctoral degree in Biological Sciences. Students who select a thesis advisor in the School of Medicine (Departments of Biological Chemistry, Microbiology and Molecular Genetics, Pathology and Laboratory Medicine, and Physiology and Biophysics) will complete the doctoral degree in Biomedical Sciences.

During the second year and beyond, students participate in the departmental doctoral program. Students are required to meet all doctoral degree requirements associated with the thesis advisor’s department or program, and may be required to take additional course work, and participate in journal club and seminar series. The normative time for completion of the Ph.D. is five years, and the maximum time permitted is seven years. Further information is available in the Catalogue sections of the participating departments and through the MCB program office.

**Graduate Program in Mathematical and Computational Biology**

Center for Complex Biological Systems

Qing Nie, Director
2624 Biological Sciences III
949-824-4120
http://mcsb.uci.edu/
mcsb@uci.edu

The graduate program in Mathematical and Computational Biology (MCB) is a one-year program designed to function in concert with existing departmental programs. Students who successfully complete the MCB program select a thesis advisor from among the participating faculty and then automatically join a departmental program for the remainder of their Ph.D. training. In this way, the MCB serves not as a degree-granting program, but as a “gateway” toward a Ph.D. degree in an existing degree program.

The MCB program provides students with an opportunity for a broad introductory training in mathematical and computational biology, individualized faculty counseling on curricular needs, and exposure to a large and diverse group of faculty and research projects in participating departments of the program. Member departments include Biomedical Engineering, Computer Science, Developmental and Cell Biology, Ecology and Evolutionary Biology, Mathematics, Microbiology and Molecular Genetics, and Molecular Biology and Biochemistry. (Other actively participating departments are Chemistry and Physics; admission to these departments via MCB is currently under review.)

The MCB curriculum is designed to teach students at the beginning of their graduate studies the necessary mathematical, computational, and biological knowledge for successful research at the interface between these disciplines. The needs of students with a variety of backgrounds can be met provided that they have had mathematical training comparable to a standard one-year university-level calculus course and a lower-division university course in elementary differential equations and linear algebra. Exceptional students not meeting these prerequisites may be admitted to the program on the condition that they fulfill these requirements during the first fall quarter of their graduate study or the summer preceding, and pass with a grade of B or better.

All first-year students normally take six four-unit MCB core courses, three quarters in mathematical and computational methods for biology and three in biological sciences. Research laboratory rotations constitute an important component of the first-year training program, providing students with intensive introductions to experimental design and quantitative data analysis as well as familiarizing them with available research opportunities. Students are expected to conduct three rotations in different labs prior to choosing a thesis advisor. Because of the interdisciplinary nature of the MCB program and the diversity of the enrolled students, MCB students are expected to become familiar with both “wet” experimental biology labs as well as with mathematical/computational laboratories.

At the end of the first year, each student will choose a primary thesis advisor from among the participating faculty of the member departments, and will enroll in a departmental Ph.D. program with which the thesis advisor is affiliated. To ensure interdisciplinarity of the thesis project, students who complete the MCB program choose a secondary thesis advisor from a department complementary to the primary thesis advisor’s department. Although completion of the Ph.D. will be subject to the degree requirements of the departmental Ph.D. program in which the student enrolls, participating departments have agreed to accept both the course work and research conducted during the MCB gateway year in partial fulfillment of such requirements. The degree to which this is applicable varies. Students must consult with the department of choice for more specific information.

**Interdepartmental Neuroscience Program**

Karina S. Cramer, Director
4145 Natural Sciences II
949-824-6226
http://www.inp.uci.edu/
gary.roman@uci.edu (gp-inp@uci.edu)

The Interdepartmental Neuroscience Program (INP) is a first-year graduate program that brings together more than 90 faculty from the Francisco J. Ayala School of Biological Sciences and the School of Medicine, including participation from the Departments of Anatomy and Neurobiology,
Developmental and Cell Biology, Molecular Biology and Biochemistry, Neurobiology and Behavior, Pharmacology, and Physiology and Biophysics. INP faculty have broad research interests in behavioral neuroscience, brain aging, developmental neurobiology, genetics, learning and memory, molecular neurobiology, cellular neurobiology, neural injury/disorders/repair, neuropharmacology, plasticity, and sensory neuroscience. Neuroscience as a discipline requires scientists to have a detailed understanding of at least one field, and a broad understanding of many other fields. INP provides breadth early on, followed by specialization in years two through five of predoctoral training.

INP organizes and coordinates a core curriculum that provides a foundation in neuroscience and forms the basis of future specialized instruction in a participating departmental degree-granting program. This curriculum includes course work and laboratory rotations. Each trainee is individually mentored in tailoring an appropriate course of study based on academic background, interests, and research foci. After successfully completing the academic requirements of the program, students identify a thesis advisor who is willing to accept them into their laboratory, and the student will transfer to the doctoral program in their advisor’s home department. In this way, INP serves not as a degree-granting program, but as a gateway to further graduate training. Students are required to meet all doctoral degree requirements associated with the thesis advisor’s department or program.

In particular, the program provides trainees with an opportunity: (1) to begin training in neuroscience with a broad academic introduction, (2) to receive individualized attention to curricular needs, (3) to conduct initial research projects with a large and diverse group of faculty in a wide variety of departments, and (4) to conduct dissertation research in any of a large and diverse group of laboratories in a wide variety of departments.

In the first year of study, students must successfully complete one course from each of the molecular, systems, and cellular neuroscience categories. All trainees also participate in a two-unit course called Foundations of Neuroscience (NEURBIO 202A-NEURBIO 202B-NEURBIO 202C). This mandatory course meets in the fall and winter quarters and is intended to expose students to research in neuroscience and critical reading and analysis of the primary literature. Students are encouraged to carry out three laboratory rotations of 10 weeks each. With permission from the director and the dean, students may carry out fewer rotations. Rotations are graded on a Satisfactory/Unsatisfactory Only scale. Trainees are judged as having successfully completed the program provided that they have: (1) achieved at least a B+ (3.3) average in the core courses, (2) achieved a satisfactory grade in each quarter of Foundations of Neuroscience, (3) achieved satisfactory grades in all rotations, and (4) identified a participating faculty member who has agreed to serve as their thesis advisor.

The ideal INP candidate will have had a substantial subset of the following courses: biology, chemistry, physics, calculus, neuroscience, psychology, biochemistry, and genetics. Preference will be given to applicants who have had laboratory research experience.

Following completion of the INP and selection of a thesis mentor, students will become members of the faculty member’s participating department. In addition to the INP course work requirements, each department has specific requirements to be fulfilled, indicated below. Students who select a thesis advisor in the Francisco J. Ayala School of Biological Sciences (Department of Developmental and Cell Biology, Molecular Biology and Biochemistry, or Neurobiology and Behavior) will complete the doctoral degree in Biological Sciences. Students who select an advisor in the School of Medicine (Department of Anatomy and Neurobiology, Pharmacology, or Physiology and Biophysics) will complete the doctoral degree in Biomedical Sciences.

Developmental and Cell Biology (Francisco J. Ayala School of Biological Sciences): Students entering the Developmental and Cell Biology program are required to enroll in and attend the weekly Department seminar series (DEV BIO 290A-DEV BIO 290B-DEV BIO 290C) and Developmental and Cell Biology journal club (DEV BIO 206A-DEV BIO 206B-DEV BIO 206C). Two quarters of teaching under the supervision of Departmental faculty are required. Student training will also be individually assessed for possible courses with an emphasis in molecular, developmental biology, or genetics as deemed necessary for successful completion of the thesis research project.

Molecular Biology and Biochemistry (Francisco J. Ayala School of Biological Sciences): Students entering the Molecular Biology and Biochemistry program are required to enroll in and attend the weekly Department seminar series (MOL BIO 201A-MOL BIO 201B-MOL BIO 201C) and the Research in Progress Seminar (MOL BIO 229), where they will present their own work annually. Students will enroll in University Teaching (DEV BIO 399) and teach (TA) beginning in their second year for at least two quarters. Student training will also be individually assessed to include at least one formal graduate course in each of the second through fifth years with an emphasis in molecular biology or biochemistry as deemed necessary for successful completion of the thesis research project. Necessary courses will include two core classes (MOL BIO 203-MOL BIO 204).

Neurobiology and Behavior (Francisco J. Ayala School of Biological Sciences): Neurobiology and Behavior accepts any of the INP core courses toward the requirement of one each from Cellular, Molecular, Systems, and Behavioral categories. INP students who enter Neurobiology and Behavior in their second year must complete the fourth category if they only fulfilled three as INP students. In addition, they will fulfill the requirements met by all continuing students, including teaching (TA) beginning in their second year for at least two quarters, advancing to candidacy in their third year, annual meetings with an advisory committee, and completing four advanced courses prior to defending their dissertation in their fifth year. They also participate in the regular Department colloquia. Students also present their research annually in the graduate student NeuroBlitz colloquium series.

Anatomy and Neurobiology (School of Medicine): Students entering the Anatomy and Neurobiology program are required to participate in the Current Topics in Neuroscience journal club (ANATOMY 227A-ANATOMY 227B-ANATOMY 227C) and attend all Department-sponsored seminars. They are also required to meet once each year with an advisory committee to monitor their progress and present their research at the annual “Grad Day” meeting. Individual advisors may require students to take other courses depending on their interests and research program.

Pharmacology (School of Medicine): Students entering the Pharmacological Sciences program through the INP are required to complete Statistics (PHARM 256) and Ethics (PHARM 257) during the summer. They will also fulfill the requirements met by all continuing students including the seminar series (PHARM 298) and graduate research (PHARM 299). The seminar series includes a journal club and research presentation component. Students
will also have the opportunity to present their research at an annual Departmental Research Symposium. Students are expected to advance to candidacy by year three and to meet with their thesis committee annually.

Physiology and Biophysics (School of Medicine): Students entering the Physiology program through the INP are required to enroll each quarter in Topics in Physiology (PHYSIO 290) and to attend all meetings of the Physiology and Biophysics journal club, all Physiology and Biophysics Departmental seminars and lunch meetings with the seminar speaker, and the Research in Progress seminars. All students are required to present their research once a year at the Research in Progress program. Students are encouraged, but not required, to enroll in Physiology of Ion Channels (PHYSIO 232) and Proteomics (PHYSIO 252). All students are required to hold meetings with their thesis committee annually, beginning in their second year. The Department has no formal teaching requirements, but students who wish to gain experience as Teaching Assistants (TA) can make arrangements to do so in coordination with the director of Graduate Studies for the Department of Physiology and Biophysics.

Faculty

Dritan Agalliu, Ph.D. Columbia University, Assistant Professor of Developmental and Cell Biology (molecular, cellular, and genetic analysis of mammalian blood-brain barrier development, the role of the barrier in disease pathogenesis)

Nancy M. Aguilar-Roca, Ph.D. University of California, San Diego, Lecturer with Potential Security of Employment of Ecology and Evolutionary Biology

Steven D. Allison, Ph.D. Stanford University, Associate Professor of Ecology and Evolutionary Biology; Earth System Science

Joseph Arditti, Ph.D. University of Southern California, Professor Emeritus of Developmental and Cell Biology (developmental physiology of orchids)

Kavita Arora, Ph.D. University of Bombay, Professor of Developmental and Cell Biology (Drosophila development; TGF-β signal transduction; cell signaling)

Dana W. Aswad, Ph.D. University of California, Berkeley, Professor of Molecular Biology and Biochemistry

Peter R. Atsatt, Ph.D. University of California, Los Angeles, Professor Emeritus of Ecology and Evolutionary Biology

Scott Atwood, Ph.D. University of Oregon, Assistant Professor of Developmental and Cell Biology

John C. Avise, Ph.D. University of California, Davis, UCI Distinguished Professor of Ecology and Evolutionary Biology

Francisco J. Ayala, Ph.D. Columbia University, Donald Bren Professor and University Professor of Ecology and Evolutionary Biology; Logic and Philosophy of Science

Manny Azizi, Ph.D. University of Massachusetts, Assistant Professor of Ecology and Evolutionary Biology

Pierre F. Baldi, Ph.D. California Institute of Technology, UCI Chancellor's Professor of Computer Science; Biological Chemistry; Biomedical Engineering; Developmental and Cell Biology (bioinformatics, computational biology)

Alan G. Barbour, M.D. Tufts University, Professor of Microbiology and Molecular Genetics; Ecology and Evolutionary Biology; Medicine

Lee Bardwell, Ph.D. Stanford University, Professor of Developmental and Cell Biology (intracellular signaling in development and disease)

Lbachir Benmohamed, Ph.D. Pasteur Institute, Associate Professor in Residence of Ophthalmology; Molecular Biology and Biochemistry

Albert F. Bennett, Ph.D. University of Michigan, Professor Emeritus of Ecology and Evolutionary Biology

Rudi C. Berkelhamer, Ph.D. University of California, Berkeley, Senior Lecturer Emerita of Ecology and Evolutionary Biology

Hans-Ulrich Bernard, Ph.D. University of Goettingen, Professor of Molecular Biology and Biochemistry; Program in Public Health

Michael W. Berns, Ph.D. Cornell University, Arnold and Mabel Beckman Chair in Laser Biomedicine and Professor of Surgery; Biomedical Engineering; Developmental and Cell Biology (photomedicine, laser microscopy, biomedical devices)

Bruce Blumberg, Ph.D. University of California, Los Angeles, Professor of Developmental and Cell Biology; Biomedical Engineering; Environmental Health Sciences; Pharmaceutical Sciences (gene regulation by nuclear hormone receptors in vertebrate development physiology, endocrine disruption)

Mathew M. Blurton-Jones, Ph.D. University of California, San Diego, Assistant Professor of Neurobiology and Behavior

Hans R. Bode, Ph.D. Yale University, Professor Emeritus of Developmental and Cell Biology (molecular basis of pattern formation in Hydra)

Alexander D. Boiko, Ph.D. University of Illinois at Urbana–Champaign, Assistant Professor of Molecular Biology and Biochemistry

Peter A. Bowler, Ph.D. University of California, Irvine, Senior Lecturer of Ecology and Evolutionary Biology

Matthew E. Bracken, Ph.D. Oregon State University, Associate Professor of Ecology and Evolutionary Biology
Timothy J. Bradley, Ph.D. University of British Columbia, **Professor of Ecology and Evolutionary Biology**

Timothy Bredy, Ph.D McGill University, **Assistant Professor of Neurobiology and Behavior**

Adriana D. Briscoe, Ph.D. Harvard University, **Professor of Ecology and Evolutionary Biology**

Peter J. Bryant, Ph.D. University of Sussex, **Research Professor and Professor Emeritus of Developmental and Cell Biology** (tumor-suppressor genes of Drosophila and humans)

Susan V. Bryant, Ph.D. University of London, **Professor Emerita of Developmental and Cell Biology** (molecular basis of limb development and regeneration)

Michael J. Buchmeier, Ph.D. McMaster University, **Professor of Medicine; Microbiology and Molecular Genetics; Molecular Biology and Biochemistry**

Nancy T. Burley, Ph.D. University of Texas at Austin, **Professor of Ecology and Evolutionary Biology**

Jorge A. Busciglio, Ph.D. Universidad Nacional de Córdoba, **Professor of Neurobiology and Behavior**

Robin M. Bush, Ph.D. University of Michigan, **Associate Professor of Ecology and Evolutionary Biology**

Lawrence F. Cahill, Ph.D. University of California, Irvine, **Professor of Neurobiology and Behavior; Cognitive Sciences**

Anne L. Calof, Ph.D. University of California, San Francisco, **Professor of Anatomy and Neurobiology; Developmental and Cell Biology** (neurogenesis and neuronal differentiation)

Diane R. Campbell, Ph.D. Duke University, **Professor of Ecology and Evolutionary Biology**

Richard D. Campbell, Ph.D. The Rockefeller University, **Professor Emeritus of Developmental and Cell Biology** (Morphogenesis; biology of Hydra; fractal geometry of biological forms)

F. Lynn Carpenter, Ph.D. University of California, Berkeley, **Professor Emerita of Ecology and Evolutionary Biology**

Ken W. Cho, Ph.D. University of Pennsylvania, **Professor of Developmental and Cell Biology** (TGF-ß signaling, gene regulatory networks in development)

Olivier Cinquin, Ph.D. University College London, **Assistant Professor of Developmental and Cell Biology** (mathematical modeling of networks, systems biology)

Olivier Civelli, Ph.D. Swiss Federal Institute of Technology in Zurich, **Department Chair and Eric L. and Lila D. Nelson Chair in Neuropharmacology and Professor of Pharmacology; Developmental and Cell Biology; Pharmaceutical Sciences** (novel neuroactive molecules)

Michael T. Clegg, Ph.D. University of California, Davis, **Donald Bren Professor and Professor Emeritus of Ecology and Evolutionary Biology**

Melanie Cocco, Ph.D. Pennsylvania State University, **Associate Professor of Molecular Biology and Biochemistry; Pharmaceutical Sciences**

Susana Cohen-Cory, Ph.D. The Rockefeller University, **Professor of Neurobiology and Behavior**

Carl W. Cotman, Ph.D. Indiana University, **Professor of Neurology; Biomedical Engineering; Neurobiology and Behavior**

Karina S. Cramer, Ph.D. California Institute of Technology, **Associate Professor of Neurobiology and Behavior**

Michael G. Cumsky, Ph.D. University of California, Berkeley, **Senior Lecturer of Molecular Biology and Biochemistry**

Rowland H. Davis, Ph.D. Harvard University, **Professor Emeritus of Molecular Biology and Biochemistry**

Michelle Digman, Ph.D. University of Illinois at Chicago, **Assistant Professor of Biomedical Engineering; Chemical Engineering and Materials Science; Developmental and Cell Biology** (quantitative imaging techniques to study spatial-temporal dynamics of signaling protein networks in live cells and tissues)

Peter J. Donovan, Ph.D. University College London, **Professor of Biological Chemistry; Developmental and Cell Biology** (stem cell biology)

Aimee Lara Edinger, Ph.D. University of Pennsylvania, **Associate Professor of Developmental and Cell Biology** (cancer biology and metabolism, growth control, protein trafficking)

James J. Emerson, Ph.D. University of Chicago, **Assistant Professor of Ecology and Evolutionary Biology**

German A. Enciso Ruiz, Ph.D. Rutgers, the State University of New Jersey, **Associate Professor of Mathematics; Developmental and Cell Biology** (applied and computational mathematics, mathematical and computational biology)
Hung Y. Fan, Ph.D. Massachusetts Institute of Technology, Professor of Molecular Biology and Biochemistry
Norbert Fortin, Ph.D. Boston University, Assistant Professor of Neurobiology and Behavior
Donald E. Fosket, Ph.D. University of Idaho, Professor Emeritus of Developmental and Cell Biology (regulation of cytoskeleton formation and function)
Christie Fowler, Ph.D. Florida State University, Assistant Professor of Neurobiology and Behavior
Steven A. Frank, Ph.D. University of Michigan, Professor of Ecology and Evolutionary Biology; Logic and Philosophy of Science
Ron D. Frostig, Ph.D. University of California, Los Angeles, Professor of Neurobiology and Behavior; Biomedical Engineering
David A. Fruman, Ph.D. Harvard University, Professor of Molecular Biology and Biochemistry
Christine M. Gall, Ph.D. University of California, Irvine, Professor of Anatomy and Neurobiology; Neurobiology and Behavior
Sunil P. Gandhi, Ph.D. University of California, San Diego, Assistant Professor of Neurobiology and Behavior
David M. Gardiner, Ph.D. University of California, San Diego, Professor of Developmental and Cell Biology (limb development and regeneration)
Brandon S. Gaut, Ph.D. University of California, Riverside, Professor of Ecology and Evolutionary Biology
Donovan German, Ph.D. University of Florida, Assistant Professor of Ecology and Evolutionary Biology
Paul David Gershon, Ph.D. University of Liverpool, Professor of Molecular Biology and Biochemistry
Charles Glabe, Ph.D. University of California, Davis, Professor of Molecular Biology and Biochemistry
Michael L. Goulden, Ph.D. Stanford University, Department Vice Chair and Professor of Earth System Science; Ecology and Evolutionary Biology
Celia Goulding, Ph.D. King's College London, Professor of Molecular Biology and Biochemistry; Pharmaceutical Sciences
Gale A. Granger, Ph.D. University of Washington, Professor Emerita of Molecular Biology and Biochemistry
Enrico Gratton, Ph.D. University of Rome, Professor of Biomedical Engineering; Developmental and Cell Biology; Physics and Astronomy (design of new fluorescence instruments, protein dynamics, single molecule, fluorescence microscopy, photon migration in tissues)
Kim Green, Ph.D. University of Leeds, Assistant Professor of Neurobiology and Behavior
Steven P. Gross, Ph.D. University of Texas at Austin, Professor of Developmental and Cell Biology; Biomedical Engineering; Physics and Astronomy (force generation by molecular motors in living cells)
John F. Guzowski, Ph.D. University of California, Irvine, James L. McGaugh Chair in the Neurobiology of Learning and Memory and Associate Professor of Neurobiology and Behavior
Barbara A. Hamkalo, Ph.D. University of Massachusetts, Professor Emerita of Molecular Biology and Biochemistry
Bradford A. Hawkins, Ph.D. University of California, Riverside, Professor of Ecology and Evolutionary Biology
Patrick L. Healey, Ph.D. University of California, Berkeley, Professor Emeritus of Developmental and Cell Biology (plant cellular differentiation and morphogenesis, ultrastructure and histochemistry of secretory systems, early reproductive development)
L. R. Herman, B.S. University of California, Irvine, Academic Coordinator of Biological Sciences
James W. Hicks, Ph.D. University of New Mexico, Professor of Ecology and Evolutionary Biology
Franz J. Hoffmann, Ph.D. University of Hohenheim, Senior Lecturer with Security of Employment Emeritus of Developmental and Cell Biology (regeneration of cultured plant cells, somatic cell genetics)
Yilin Hu, Ph.D. Loma Linda University, Assistant Professor of Molecular Biology and Biochemistry
Bradley S. Hughes, Ph.D. University of California, Irvine, Lecturer with Security of Employment of Ecology and Evolutionary Biology; Education
Christopher C. Hughes, Ph.D. University of London, Interim Director of Edwards Lifesciences Cardiovascular Technology Center and Professor of Molecular Biology and Biochemistry; Biomedical Engineering (tissue engineering, growth and patterning of blood vessels)
George L. Hunt, Jr., Ph.D. Harvard University, Professor Emeritus of Ecology and Evolutionary Biology
Travis E. Huxman, Ph.D. University of Nevada, Professor of Ecology and Evolutionary Biology
Matthew Inlay, Ph.D. University of California, San Diego, Assistant Professor of Molecular Biology and Biochemistry

Mahtab F. Jafari, Ph.D. University of California, San Francisco, Vice Chair of the Undergraduate Program in Pharmaceutical Sciences and Associate Professor of Pharmaceutical Sciences; Ecology and Evolutionary Biology; Pharmacology

Anthony A. James, Ph.D. University of California, Irvine, UCI Distinguished Professor of Microbiology and Molecular Genetics; Molecular Biology and Biochemistry

Pavan Kadandale, Ph.D. Rutgers, The State University of New Jersey, Lecturer with Potential Security of Employment of Molecular Biology and Biochemistry

Claudia H. Kawas, M.D. University of Louisville, Nichols Term Chair in Neuroscience and Professor of Neurology; Epidemiology; Neurobiology and Behavior

Daniel J. Knauer, Ph.D. University of Nebraska, Professor Emeritus of Developmental and Cell Biology (human antithrombins and related serine protease inhibitors)

Natalia Komarova, Ph.D. University of Arizona, Professor of Mathematics; Ecology and Evolutionary Biology (applied and computational mathematics, mathematical and computational biology, mathematics of complex and social phenomena)

Harold Koopowitz, Ph.D. University of California, Los Angeles, Professor Emeritus of Ecology and Evolutionary Biology

Stuart M. Krassner, SCE Johns Hopkins University, Professor Emeritus of Developmental and Cell Biology (developmental transitions of hemoflagellates)

Yeong Jik Kwon, Ph.D. University of Southern California, Associate Professor of Pharmaceutical Sciences; Biomedical Engineering; Chemical Engineering and Materials Science; Molecular Biology and Biochemistry (gene therapy, drug delivery, cancer-targeted therapeutics, combined molecular imaging and therapy, cancer vaccine)

Frank M. Laferla, Ph.D. University of Minnesota, Dean of the Francisco J. Ayala School of Biological Sciences and Professor of Neurobiology and Behavior; Neurology

Arthur D. Lander, Ph.D. University of California, San Francisco, Donald Bren Professor and Professor of Developmental and Cell Biology; Biomedical Engineering; Logic and Philosophy of Science; Pharmacology (systems biology of development, pattern formation, growth control)

Thomas E. Lane, Ph.D. University of California, Los Angeles, Professor of Molecular Biology and Biochemistry

Abraham P. Lee, Ph.D. University of California, Berkeley, William J. Link Chair in Biomedical Engineering and Department Chair and Professor of Biomedical Engineering; Mechanical and Aerospace Engineering; Molecular Biology and Biochemistry (Lab-on-a-Chip health monitoring instruments, drug delivery micro/nanoparticles, integrated cell sorting microdevices, lipid vesicles as carriers for cells and biomolecules, high throughput droplet bioassays, microfluidic tactile sensors)

Michael Leon, Ph.D. University of Chicago, Professor of Neurobiology and Behavior

Shin Lin, Ph.D. University of California, Los Angeles, Professor of Developmental and Cell Biology; Biomedical Engineering (combined use of biochemistry, cell biology, molecular biology, molecular biophysics to study the structure and function of proteins involved in cytoskeletal/contractile functions and signal transduction in muscle and nonmuscle cells)

Melissa Lodoen, Ph.D. University of California, San Francisco, Assistant Professor of Molecular Biology and Biochemistry

Anthony D. Long, Ph.D. McMaster University, Professor of Ecology and Evolutionary Biology; Pharmaceutical Sciences

Catherine Loudon, Ph.D. Duke University, Senior Lecturer of Ecology and Evolutionary Biology

Ulrike Luderer, M.D., Ph.D. Northwestern University, Professor of Medicine; Developmental and Cell Biology; Environmental Health Sciences; Program in Public Health (reproductive toxicology, developmental toxicology, developmental basis of ovarian toxicity, ovarian cancer)

Hartmut Luecke, Ph.D. William Marsh Rice University, Professor of Molecular Biology and Biochemistry; Molecular Biology and Biochemistry; Physiology and Biophysics

Ray Luo, Ph.D. University of Maryland, College Park, Professor of Molecular Biology and Biochemistry; Biomedical Engineering; Chemical Engineering and Materials Science (protein structure, noncovalent associations involving proteins)

Andrej Luptak, Ph.D. Yale University, Vice Chair of Graduate Programs in Pharmaceutical Sciences and Associate Professor of Pharmaceutical Sciences; Chemistry; Molecular Biology and Biochemistry (chemical biology)
Grant R. MacGregor, Ph.D. University of Sussex, Associate Professor of Developmental and Cell Biology (mouse reproduction, development, homeostasis)

Richard E. MacMillen, Ph.D. University of California, Los Angeles, Professor Emeritus of Ecology and Evolutionary Biology

Stephen V. Mahler, Ph.D. University of Michigan, Assistant Professor of Neurobiology and Behavior

Jerry E. Manning, Ph.D. University of Utah, Professor Emeritus of Molecular Biology and Biochemistry

J. Lawrence Marsh, Ph.D. University of Washington, Professor of Developmental and Cell Biology (mechanisms of neurodegeneration and molecular genetics of development)

John F. Marshall, Ph.D. University of Pennsylvania, Professor Emeritus of Neurobiology and Behavior

Rachel Martin, Ph.D. Yale University, Associate Professor of Chemistry; Molecular Biology and Biochemistry (analytical, chemical biology, physical chemistry and chemical physics)

Adam Martiny, Ph.D. Technical University of Denmark, Associate Professor of Earth System Science; Ecology and Evolutionary Biology

Jennifer Martiny, Ph.D. Stanford University, Professor of Ecology and Evolutionary Biology

Maria J. Massimelli, Ph.D., Lecturer with Potential Security of Employment of Molecular Biology and Biochemistry

Debra K. Mauzy-Mellitz, Ph.D. Marquette University, Lecturer with Potential Security of Employment of Developmental and Cell Biology (role of writing in scientific teaching)

James L. McGaugh, Ph.D. University of California, Berkeley, Research Professor and Professor Emeritus of Neurobiology and Behavior; Logic and Philosophy of Science

Matthew J. McHenry, Ph.D. University of California, Berkeley, Associate Professor of Ecology and Evolutionary Biology

Bruce L. McNaughton, Ph.D. Carleton University, UCI Distinguished Professor of Neurobiology and Behavior

Alexander McPherson, Ph.D. Purdue University, Professor of Molecular Biology and Biochemistry

Raju Metherate, Ph.D. McGill University, Professor of Neurobiology and Behavior

Ronald L. Meyer, Ph.D. California Institute of Technology, Professor of Developmental and Cell Biology (development of nerve connections, nerve injury, and regeneration)

John Middlebrooks, Ph.D. University of California, San Francisco, Professor of Otolaryngology; Biomedical Engineering; Cognitive Sciences; Neurobiology and Behavior

Ricardo Miledi, M.D. Universidad Nacional Autonoma De Mexico, Professor Emeritus of Neurobiology and Behavior

Kivie Moldave, Ph.D. University of California, Berkeley, Professor Emeritus of Molecular Biology and Biochemistry

Edwin S. Monuki, M.D. University of California, San Diego, Assistant Professor of Developmental and Cell Biology (cerebral cortex, choroid plexus development, translation)

Kailen Mooney, Ph.D. University of Colorado Boulder, Associate Professor of Ecology and Evolutionary Biology

Naomi Morrissette, Ph.D. University of Pennsylvania, Associate Professor of Molecular Biology and Biochemistry

Seyed Ali Mortazavi, Ph.D. California Institute of Technology, Assistant Professor of Developmental and Cell Biology (functional genomics to study transcriptional regulation in development)

Laurence D. Mueller, Ph.D. University of California, Davis, Department Chair and Professor of Ecology and Evolutionary Biology

R. Michael Mulligan, Ph.D. Michigan State University, Biological Sciences Associate Dean of Graduate Studies and Professor of Developmental and Cell Biology; Ecology and Evolutionary Biology (RNA editing in plant mitochondria and chloroplasts)

Edward L. Nelson, M.D. University of Oregon, Associate Professor of Medicine; Molecular Biology and Biochemistry

Andrea C. Nicholas, Ph.D. University of Chicago, Lecturer with Potential Security of Employment of Neurobiology and Behavior

Diane K. O'Dowd, Ph.D. University of California, San Diego, Professor of Developmental and Cell Biology; Anatomy and Neurobiology (regulation of activity in developing and adult nervous systems)
Ian Parker, Ph.D. University College London, Professor of Neurobiology and Behavior; Physiology and Biophysics

Irene Pedersen, Ph.D. University of California, San Diego, Assistant Professor of Molecular Biology and Biochemistry

Maksim Plikus, Ph.D. University of Southern California, Assistant Professor of Developmental and Cell Biology (mechanisms of regeneration, stem cell control)

Thomas L. Poulos, Ph.D. University of California, San Diego, Professor of Molecular Biology and Biochemistry; Chemistry; Pharmaceutical Sciences; Physiology and Biophysics (chemical biology)

Jessica Pratt, Ph.D. University of California, Irvine, Lecturer with Potential Security of Employment of Ecology and Evolutionary Biology

Jennifer A. Prescher, Ph.D. University of California, Berkeley, Assistant Professor of Chemistry; Molecular Biology and Biochemistry; Pharmaceutical Sciences (chemical biology, organic and synthetic)

Susanne M. Rafelski, Ph.D. Stanford University, Assistant Professor of Developmental and Cell Biology; Biomedical Engineering (control of mitochondrial network size, topology and function in budding yeast cells)

James T. Randerson, Ph.D. Stanford University, UCI Chancellor’s Professor of Earth System Science; Ecology and Evolutionary Biology

Jose Mari Ranz Navalpotro, Ph.D. Universidad Autónoma de Madrid, Associate Professor of Ecology and Evolutionary Biology

Olga Razorenova, Ph.D. Institute of Molecular Genetics, Assistant Professor of Molecular Biology and Biochemistry

Elizabeth L. Read, Ph.D. University of California, Berkeley, Assistant Professor of Chemical Engineering and Materials Science; Molecular Biology and Biochemistry (dynamics of complex biochemical systems, regulation of immune responses)

Markus W. Ribbe, Ph.D. University of Bayreuth, Professor of Molecular Biology and Biochemistry; Chemistry (chemical biology, inorganic and organometallic)

Michael R. Rose, Ph.D. University of Sussex, Professor of Ecology and Evolutionary Biology

Ann K. Sakai, Ph.D. University of Michigan, Professor of Ecology and Evolutionary Biology

Brian Sato, Ph.D. University of California, San Diego, Lecturer with Potential Security of Employment of Molecular Biology and Biochemistry

Thomas F. Schilling, Ph.D. University of Oregon, Department Chair and Professor of Developmental and Cell Biology (zebrafish development, vertebrate genetics, craniofacial development)

Donald F. Senear, Ph.D. University of Washington, Professor of Molecular Biology and Biochemistry

Justin F. Shaffer, Ph.D. University of Washington, Lecturer with Potential Security of Employment of Developmental and Cell Biology (improving teaching and learning in college science classes)

Steven L. Small, M.D. University of Rochester, Dr. Stanley van den Noort Endowed Chair and Professor of Neurology; Cognitive Sciences; Neurobiology and Behavior

Ivan Soltesz, Ph.D. Eötvös Loránd University, UCI Chancellor's Professor of Anatomy and Neurobiology; Neurobiology and Behavior; Physiology and Biophysics

Cascade J. Sorte, Ph.D. University of California, Davis, Assistant Professor of Ecology and Evolutionary Biology

George Sperling, Ph.D. Harvard University, UCI Distinguished Professor of Cognitive Sciences; Neurobiology and Behavior

Craig Stark, Ph.D. Carnegie Mellon University, Professor of Neurobiology and Behavior

Oswald Steward, Ph.D. University of California, Irvine, Reeve-Irvine Chair in Spinal Cord Injury Research and Professor of Anatomy and Neurobiology; Neurobiology and Behavior

Geoff Striedter, Ph.D. University of California, San Diego, Professor of Neurobiology and Behavior

Christine Suetterlin, Ph.D. University of Basel, Associate Professor of Developmental and Cell Biology (centrosome and cilia regulation, Golgi, host-pathogen interaction)

Katumi Sumikawa, Ph.D. Imperial College London, Professor of Neurobiology and Behavior

Sha Sun, Ph.D. University of Chicago, Assistant Professor of Developmental and Cell Biology (long noncoding RNAs in epigenetic programming)

Richard Symanski, Ph.D. Syracuse University, Senior Lecturer of Ecology and Evolutionary Biology
Andrea Tenner, Ph.D. University of California, San Diego, Professor of Molecular Biology and Biochemistry; Neurobiology and Behavior

Krishna K. Tewari, Ph.D. University of Lucknow, Professor Emeritus of Molecular Biology and Biochemistry

Leslie M. Thompson, Ph.D. University of California, Irvine, Professor of Psychiatry and Human Behavior; Biological Chemistry; Neurobiology and Behavior

Kevin Thornton, Ph.D. University of Chicago, Associate Professor of Ecology and Evolutionary Biology

Kathleen K. Treseder, Ph.D. Stanford University, Department Vice Chair and UCI Chancellor’s Fellow and Professor of Ecology and Evolutionary Biology

Shiou-Chuan (Sheryl) Tsai, Ph.D. University of California, Berkeley, UCI Chancellor’s Fellow and Professor of Molecular Biology and Biochemistry; Chemistry; Pharmaceutical Sciences

Luis P. Villarreal, Ph.D. University of California, San Diego, Professor of Molecular Biology and Biochemistry

Craig Walsh, Ph.D. University of California, Los Angeles, Professor of Molecular Biology and Biochemistry

Rahul Warrior, Ph.D. Yale University, Associate Professor of Developmental and Cell Biology (developmental genetics of transcription and proteoglycan synthesis)

Norman M. Weinberger, Ph.D. Case Western Reserve University, Professor Emeritus of Neurobiology and Behavior; Logic and Philosophy of Science

Arthur Weis, Ph.D. University of Illinois at Urbana-Champaign, Professor Emeritus of Ecology and Evolutionary Biology

Gregory A. Weiss, Ph.D. Harvard University, Professor of Chemistry; Molecular Biology and Biochemistry (analytical, chemical biology, organic and synthetic, polymer, materials, nanoscience)

Stephen G. Weller, Ph.D. University of California, Berkeley, Professor of Ecology and Evolutionary Biology

Katrine Whiteson, Ph.D. University of Chicago, Assistant Professor of Molecular Biology and Biochemistry

Dominik Franz X. Wodarz, Ph.D. Oxford University, Professor of Ecology and Evolutionary Biology; Mathematics (mathematical biology, infectious disease and cancer)

Marcelo A. Wood, Ph.D. Princeton University, UCI Chancellor’s Fellow and Department Chair and Associate Professor of Neurobiology and Behavior

Clifford A. Woolfolk, Ph.D. University of Washington, Professor Emeritus of Molecular Biology and Biochemistry

Xiaohui Xie, Ph.D. Massachusetts Institute of Technology, Associate Professor of Computer Science; Developmental and Cell Biology (computational biology, bioinformatics, genomics, neural computation, machine learning)

Guiyun Yan, Ph.D. University of Vermont, Professor of Program in Public Health; Ecology and Evolutionary Biology; Program in Public Health

Michael Yassa, Ph.D. University of California, Irvine, Assistant Professor of Neurobiology and Behavior

**Biological Sciences Courses**

**BIO SCI 1A. Life Sciences. 4 Units.**
Designed to introduce nonmajors to the basic concepts of modern biology. Discussion of evolutionary biology, ecology, molecular biology, and genetics.

Restriction: Non-School of Biological Sciences majors only.

**BIO SCI 2A. Freshman Seminar. 2 Units.**
Weekly meetings consisting of presentations by faculty, professional staff, and Peer Academic Advisors provide information about the School of Biological Sciences, campus resources, learning skills, and special programs/opportunities.

Grading Option: Pass/no pass only.

Restriction: Freshmen only. Biological Sciences majors only.

**BIO SCI 2B. Freshman Seminar. 1 Unit.**
Faculty presentations and readings focused on the structure, function, opportunities, and current issues in the biological sciences.

Grading Option: Pass/no pass only.

Restriction: Biological Sciences majors only. Freshman only.
BIO SCI 2C. Solutions in Science. 1 Unit.
Students will be introduced to approaches that can be used to solve scientific problems. These methods can be utilized in introductory to advanced classes and will allow students to become independent thinkers.

BIO SCI 3A. Career Decision Making. 1 Workload Unit.
An introductory course designed to facilitate the career decision-making process. Decision-making processes, values, and standardized tests of aptitudes, interests, and values are utilized with non-test data in appraising biological sciences career options.

Grading Option: Pass/no pass only.
Restriction: Biological Sciences majors only.

BIO SCI 3B. Non-Health Sciences Career Exploration. 1 Workload Unit.
A survey course designed to assist students in exploring non-health science career options. Lectures by professionals in various fields.

Grading Option: Pass/no pass only.

BIO SCI 9A. Nutrition Science. 4 Units.
An introduction to nutrition science, integrating concepts from biology, biochemistry, microbiology, physiology, and psychology to explain the interaction between nutrients and the human body. Biological basis of nutrient standards is analyzed. Effects of nutrition, behavior, exercises on health/disease.

BIO SCI 9B. Biology and Chemistry of Food and Cooking. 4 Units.
The kitchen is used as a laboratory to introduce fundamental principles of biology, chemistry, and physics. A molecular/cellular analysis of cooking, including concepts such as protein structure, browning reactions, colloids, emulsions, carbohydrate metabolism, and development of flavor/textures through biochemical transformations.

Restriction: Non-Bio Sci majors only.

BIO SCI 9D. Diseases of the Twenty-First Century. 4 Units.
Why do we get sick? An introduction to the biological basis of human disease, including diseases of the cardiovascular, respiratory, nervous, and reproductive systems. Case studies present diagnosis, treatment, and prevention protocols. Inheritable and infectious diseases also discussed.

Overlaps with BIO SCI 10, BIO SCI 12D.

BIO SCI 9E. Horticulture Science. 4 Units.
Scientific principles of horticulture at the UCI Arboretum. Taxonomy, plant life history strategies; experiments with seed dormancy; morphological adaptations for specialized sexual and clonal reproduction; basics of plant propagation and ecological restoration. Materials fee.

BIO SCI 9J. Biology of Oriental Medicine. 4 Units.
With lectures, demonstrations, and hands-on learning, the theory and practice of herbal medicine, acupuncture, qigong, and manipulative therapies are explained in Western biomedical terms. The latest basic and clinical research advances in each area are also described.

Overlaps with BIO SCI 9N, BIO SCI D124.

BIO SCI 9K. Global-Change Biology. 4 Units.
Addresses ways in which humans are altering the global environment, with consequences for the ecology of animals, plants, and microbes. Discussion on how these biologically oriented questions relate to human society, politics, and the economy.

Same as EARTHSS 13.
BIO SCI 9N. Introduction to Complementary and Alternative Medicine. 4 Units.
Basic and clinical research on complementary and alternative therapies (e.g., herbal medicine, mind-body practices, energy medicine, acupuncture, homeopathy, chiropractic, Ayurveda), and how such practices are integrated into Western medicine are discussed. Includes lectures, demonstrations, and hands-on learning.

Overlaps with BIO SCI 9J, BIO SCI 9D, BIO SCI 10, BIO SCI D124.

Restriction: Non-Biological Science majors only.

BIO SCI 10. The Biology of Human Diseases. 4 Units.

Overlaps with BIO SCI 9D, BIO SCI 12D.

BIO SCI 11. Topics in Biological Sciences. 4 Units.
Studies in selected areas of biological sciences.

Repeatability: May be taken for credit 3 times.

BIO SCI 14. California Teach 1: Introduction to Science and Mathematics Teaching. 3 Units.
First in a series for students interested in becoming middle or high school teachers of mathematics or science. Students gain an understanding of effective, research-based teaching strategies. Includes supervised field experience in a K-12 classroom.

Same as PHY SCI 5.

Restriction: School of Physical Sciences, School of Biological Sciences, School of Information and Computer Sciences, and School of Engineering majors have first consideration for enrollment.

BIO SCI 23. Sustainable Landscaping: Design and Practices. 4 Units.
Through lectures and hands-on work, students learn how to design habitats around dwellings, within cities, and in rural environments. These include traditional/sustainable landscaping, restoration, stormwater/wastewater treatment, xeriscaping, and low impact development design. Sustainable landscape plant materials emphasized.

BIO SCI 25. Biology of Cancer. 4 Units.
Biological, clinical, and psychosocial nature of cancer through the perspectives of medical researchers, biologists, physicians, and health educators. For students of all majors, designed so that each can increase personal awareness of the biology of cancer.

Restriction: BIO SCI 25 may not be taken for credit if taken after BIO SCI M125.

BIO SCI 35. The Brain and Behavior. 4 Units.
Introduction to how the brain works. Biological processes underlying perception, movement, sleep-wake cycles, motivation, language, learning, and memory. Changes in the brain associated with sex differences, drug use, aging, seasons, and time of day. Fundamental properties of the nervous system.

Restriction: Non-Biological Sciences majors only.

BIO SCI 36. Drugs and the Brain. 4 Units.

Restriction: Non-Biological Sciences majors only.
BIO SCI 37. Brain Dysfunction and Repair. 4 Units.
Introduction to the disruptions in brain function that underlie disorders such as Alzheimer’s disease, Parkinsonism, schizophrenia, and depression, and the basis for drug therapies. The brain’s ability to repair itself after damage and the pros and cons of that repair.

Restriction: Non-Biological Sciences majors only.

BIO SCI 38. Mind, Memory, Amnesia, and the Brain. 4 Units.
Introduction to neural mechanisms underlying learning and memory. Emphasis on molecular changes that mediate memory as well as structures involved in different forms of memory. Additionally, examines the biology of memory phenomena, from extraordinary memory to false memory to amnesia.

Restriction: Non-Biological Sciences majors only.

BIO SCI 41. Aspects of Mood Disorder. 4 Units.
There are significant differences in response to psychiatric illness across cultures. Delves into the neuroscience underlying mood disorder, investigating current pharmacological treatments and sociocultural influences on treatment outcomes.

Restriction: Non-School of Biological Sciences majors only.

BIO SCI 42. Origin of Life. 4 Units.
Biochemical explanations for the origin of life are presented. Topics include definitions of life, the first replicating molecules, the first catalyzed biosynthesis and metabolism, the origin of cells (compartmentalization) and the origins of information and the genetic code.

BIO SCI 43. Media on the Mind. 4 Units.
Surveys an ever-increasing collection of research, suggesting modern technology and social media are changing in the way our brains function.

Restriction: Non-Biological Sciences majors only.

BIO SCI 44. Stem Cells and Brain Repair. 4 Units.
Students introduced to the field of regenerative neurobiology. Both basic stem cell discoveries and their potential clinical application to brain disorders examined. Discussion of opportunities, challenges, and implications of this research.

Overlaps with BIO SCI N172.

Restriction: Non-Biological Sciences majors only.

BIO SCI 45. AIDS Fundamentals. 4 Units.
Considers the biological and sociological bases of the AIDS epidemic. Topics include the history of AIDS, current medical knowledge, transmission, risk reduction, and how the community can respond.

Same as PUBHLTH 80.

BIO SCI 46. Discussion and Literature Research in AIDS. 2-4 Units.
Students carry out two activities: (1) leading discussions about HIV/AIDS (predominantly regarding sociological and personal reactions) among students taking the AIDS Fundamentals course and (2) literature research about biomedical aspects of AIDS.

Prerequisite: BIO SCI 45 or PUBHLTH 80.

BIO SCI 47. Stress. 4 Units.
Investigates stress at a psychological, physiological, and molecular level, and provides a current overview of the field of stress research.

Restriction: Non-Biological Sciences majors only.
BIO SCI 55. Introduction to Ecology. 4 Units.
Principles of ecology; application to populations, communities, ecosystems, and humans.
Restriction: Non-Biological Sciences majors only. BIO SCI 55 may not be taken for credit if taken after BIO SCI 96 or BIO SCI E106.

BIO SCI 75. Human Development: Conception to Birth. 4 Units.
Processes leading to the birth of a healthy child and the avoidance of birth defects. Male and female reproductive systems, hormonal control of egg-sperm formations, sexual intercourse, contraception, venereal diseases, fertilization, cell division, embryonic development, fetal physiology.
Restriction: Non-Biological Science majors only.

BIO SCI H90. The Idiom and Practice of Science. 4 Units.
The importance of biological sciences in our world is discussed. Topics may include brain and behavior, health and disease, genetics and society, and conservation biology. Primary goal is to encourage students to understand better the world in which they live.
Restriction: Campuswide Honors Program students only.

BIO SCI 92. Curriculum. 1-4 Units.
Initiation, planning, and coordination of student-run courses.
Grading Option: Pass/no pass only.
Repeatability: May be taken for credit 12 times.
Restriction: Biological Sciences majors only.

BIO SCI 93. From DNA to Organisms. 4 Units.
Cell biology, biochemistry, genetics, and the biology of organ systems. Covers concepts of building blocks (nucleotides, amino acids, and cells) and of information flow (DNA to proteins, receptors to nuclei, the blood to distant organs, and DNA to offspring). Course may be offered online.
Restriction: BIO SCI 93 may not be taken for credit if taken after BIO SCI 97 or BIO SCI 98.

BIO SCI 94. From Organisms to Ecosystems. 4 Units.
Patterns of diversity, ecology, and evolutionary biology. Emphasis is on the Tree of Life and how its members are distributed and interact. Course may be offered online.
Prerequisite: BIO SCI 93. BIO SCI 93 with a grade of C- or better.
Restriction: BIO SCI 1A may not be taken for credit if taken after BIO SCI 94.

BIO SCI 97. Genetics. 4 Units.
Introduction to genetics. Basic features of replication and expression of DNA, cell division, and gene transmission. Recombination and mutation in diploid organisms.
Prerequisite: BIO SCI 94. BIO SCI 94 with a grade of C- or better.
Restriction: Biological Sciences, Pharmaceutical Sciences, Public Health Sciences, Biomedical Engineering: Premedical, and Nursing Science majors have first consideration for enrollment.

BIO SCI 98. Biochemistry. 4 Units.
Structure and properties of proteins; major biochemical pathways and mechanisms for their control. Course may be offered online.
Prerequisite: BIO SCI 97. BIO SCI 97 with a grade of C- or better. Prerequisite or corequisite: CHEM 51B.
Restriction: Biological Sciences, Pharmaceutical Sciences, Public Health Sciences, Biomedical Engineering: Premedical, and Nursing Science majors have first consideration for enrollment.
BIO SCI 99. Molecular Biology. 4 Units.
Biochemistry and replication of nucleic acids; molecular genetics; protein biosynthesis; genetic code; regulation of expression of genetic information; biochemical evolution.

Prerequisite: BIO SCI 98.

Restriction: Biological Sciences, Pharmaceutical Sciences, Public Health Sciences, Biomedical Engineering: Premedical, and Nursing Science majors have first consideration for enrollment.

BIO SCI 100. Scientific Writing. 3 Units.
Designed to give an overview of the basic aspects of scientific writing relevant to reporting research in the Biological Sciences.

Prerequisite: BIO SCI 99. Prerequisite or corequisite: BIO SCI 194S.

Restriction: Biological Sciences, Pharmaceutical Sciences, and Biomedical Engineering: Premedical majors have first consideration for enrollment.

BIO SCI 101. California Teach 2: Middle School Science and Mathematics Teaching. 3 Units.
Second in a series for students interested in becoming middle or high school teachers of mathematics or science. Students gain an understanding of effective, research-based teaching strategies for grades 6-8. Includes supervised field experience in a middle school classroom.

Prerequisite: PHY SCI 5.

Same as PHY SCI 105.

Restriction: School of Physical Sciences, School of Biological Sciences, School of Information and Computer Sciences, and School of Engineering majors have first consideration for enrollment.

BIO SCI 102. California Teach 3: High School Science and Mathematics Teaching. 2 Units.
Capstone of a series of three seminars for students interested in becoming secondary mathematics or science teachers. Meets six times for students to understand effective, research-based teaching strategies. Includes an opportunity to experience teaching in a high school.

Prerequisite: (PHY SCI 5 or BIO SCI 14) and (PHY SCI 105 or BIO SCI 101).

Same as PHY SCI 106.

Restriction: School of Physical Sciences, School of Biological Sciences, School of Information and Computer Sciences, and School of Engineering majors have first consideration for enrollment.

BIO SCI D103. Cell Biology. 4 Units.
Analysis of the basic structure and function of animal cells, with an emphasis on the regulation of cellular processes. The basic features of membranes, cellular compartmentalization, protein trafficking, vesicular transport, cytoskeleton, adhesion, signal transduction, and cell cycle are covered.

Prerequisite: BIO SCI 99.

Restriction: Students who require this class for completion of their degree have first consideration for enrollment.

BIO SCI D104. Developmental Biology. 4 Units.
Cellular and molecular analysis of how a fertilized egg develops into an organism consisting of complex structures such as the eye, arms, and brain. Emphasis is on the key concepts of developmental processes underlying pattern formation, growth, and regeneration.

Prerequisite: BIO SCI 99.

Restriction: Students who require this class for completion of their degree have first consideration for enrollment.

BIO SCI D105. Cell, Developmental, and Molecular Biology of Plants. 4 Units.
Emphasizes the special features of plant cells and plant development as compared to animals. Two central topics: Plants' ability to fuel our planet through photosynthesis, and the interactions of plants with microorganisms in making nitrogen available to other life forms.

Prerequisite: BIO SCI 99.

Restriction: Students who require this class for completion of their degree have first consideration for enrollment.
BIO SCI E106. Processes in Ecology and Evolution. 4 Units.
An in-depth study of the mechanisms that drive evolution and ecology including: natural selection, mutation, genetic drift, speciation, extinction, life history patterns, population dynamics, ecosystem and community structure, predator-prey and host pathogen interactions, and social behavior.
Prerequisite: BIO SCI 94.
Restriction: Students who require this class for completion of their degree have first consideration for enrollment.

BIO SCI E106L. Habitats and Organisms. 4 Units.
Introduces students to local habitats and organisms through required field trips and applies ecological and evolutionary principles from BIO SCI E106. Students also explore related literature.
Corequisite: BIO SCI E106.
Prerequisite: BIO SCI 100 and BIO SCI 194S and BIO SCI E106. Satisfactory completion of the Lower-Division Writing requirement.
Restriction: BIO SCI E106L may not be taken for credit concurrently with or after taking BIO SCI E166. Students who require this lab for completion of their degree have first consideration for enrollment.

BIO SCI E107. Seminar in Ecology and Evolutionary Biology. 2 Units.
Invited speakers, graduate students, and faculty present current research in ecology and evolutionary biology.
Grading Option: Pass/no pass only.
Restriction: Ecology and Evolutionary Biology majors only. Upper-division students only.

BIO SCI 108. Research Methods. 4 Units.
Explores tools of inquiry for developing and implementing science research projects. Students undertake independent projects requiring data collection, analysis, and modeling, and the organization and presentation of results. Additional topics include ethical issues and role of scientific literature.
Prerequisite: BIO SCI 14 or PHY SCI 5.
Same as PHYSICS 193, CHEM 193.

BIO SCI E109. Human Physiology. 4 Units.
Functional features of the major organ systems in the human body. Emphasis on homeostasis and the interactions of organ systems in health and disease. (Discussion of behavior and brain function deferred to BIO SCI N110.).
Prerequisite: BIO SCI 99.
Overlaps with PHRMSCI 120.
Restriction: Students who require this class for completion of their degree have first consideration for enrollment.

BIO SCI N110. Neurobiology and Behavior. 4 Units.
Consideration of the evolution of behavior, including ethological and psychological aspects and analysis of neuroanatomical, neurochemical, neurophysiological, and neuroendocrine systems underlying basic behavioral processes.
Prerequisite: Prerequisite or corequisite: BIO SCI 99.
Restriction: Students who require this class for completion of their degree have first consideration for enrollment.

BIO SCI D111L. Developmental and Cell Biology Laboratory. 4 Units.
Students study the division of cells, isolate cellular organelles (chloroplasts, mitochondria, nuclei), and follow changes in cells undergoing programmed cell death. Development is demonstrated in experiments showing cooperation of individual cells in forming a multicellular organism. Materials fee.
Corequisite: BIO SCI D103 or BIO SCI D104 or BIO SCI D105.
Prerequisite: BIO SCI 194S and BIO SCI 100. Prerequisite or corequisite: BIO SCI D103 or BIO SCI D104 or BIO SCI D105.
Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.

(Ib)
BIO SCI E112L. Physiology Laboratory. 4 Units.
Laboratory with a focus on the whole organism and its organ systems. Examples of structure-function relationships will be drawn from both animal and human physiology. Cellular and molecular aspects will be introduced as required. Materials fee.

Prerequisite: BIO SCI 194S and BIO SCI 100 and (BIO SCI E109 or (BME 120 and BME 121)).

Overlaps with PHRMSCI 120L.

Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.

(Ib)

BIO SCI D113. Genetics Majors Seminar. 1 Unit.
Genetics majors attend a weekly seminar to discuss current research techniques and career opportunities in the field. Students have the opportunity to present their own independent research.

Repeatability: May be taken for credit 2 times.

Restriction: Genetics majors only.

BIO SCI N113L. Neurobiology Laboratory. 3 Units.
Nature and actions of genes/gene products that regulate the functioning of the nervous system and its interaction with muscles. Topics include: neural control of gene expression; genetics and molecular biology of neural and neuromuscular diseases; gene therapies for neural disorders. Materials fee.

Prerequisite: BIO SCI 100 and BIO SCI 194S. Prerequisite or corequisite: BIO SCI N110.

Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.

(Ib)

BIO SCI D114. Developmental and Cell Biology Majors Seminar. 1 Unit.
Developmental and Cell Biology majors attend a weekly seminar to discuss current research techniques and career opportunities in the field. Students have the opportunity to present their own independent research.

Grading Option: Pass/no pass only.

Repeatability: May be taken for credit 2 times.

Restriction: Developmental and Cell Biology majors only.

BIO SCI M114. Advanced Biochemistry. 4 Units.

Prerequisite: BIO SCI 99.

BIO SCI M114L. Biochemistry Laboratory. 5 Units.
Properties of enzymes and the culture and isolation of mutants of microorganisms. Materials fee.

Prerequisite: BIO SCI 99 and BIO SCI 100 and BIO SCI 194S.

Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.

(Ib)

BIO SCI E115L. Evolution Laboratory. 4 Units.
Students perform experiments which illustrate important concepts in evolutionary biology such as natural selection, random genetic drift, inbreeding, age-specific selection, sexual selection, and phylogenetic reconstruction. Materials fee.

Corequisite: .
Prerequisite: BIO SCI 100 and BIO SCI 194S and BIO SCI E106. Satisfactory completion of the Lower-Division Writing requirement.

Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.

(Ib)
BIO SCI N115A. Advanced Neurobiology I. 4 Units.
In-depth coverage of neurobiology, ranging from molecular neurobiology to functional brain imaging. Discussion of molecular, cellular, and developmental neurobiology.
Prerequisite: BIO SCI N110.
Restriction: Neurobiology Majors.

BIO SCI N115B. Advanced Neurobiology II. 4 Units.
In-depth coverage of neurobiology, ranging from molecular neurobiology to functional brain imaging. Discussion of systems and behavioral neurobiology.
Prerequisite: BIO SCI N115A.
Restriction: Neurobiology majors only.

BIO SCI M116. Advanced Molecular Biology. 4 Units.
Mechanisms of gene expression; special emphasis on regulatory events that occur in Eukaryotic organisms other than initiation of transcription. Chromatin structure and rearrangement, RNA polymerases, cis- and trans-acting elements, RNA processing, transport and stability, protein synthesis, trafficking, and turnover.
Prerequisite: BIO SCI 99 and (BIO SCI M114L or BIO SCI M116L).

BIO SCI M116L. Molecular Biology Laboratory. 5 Units.
Students perform experiments which illustrate the chemical and biological properties of nucleic acids. Emphasis is placed on recent techniques in recombinant DNA technology including gene isolation and characterization. Materials fee.
Prerequisite: BIO SCI 99 and BIO SCI 100 and BIO SCI 194S.
Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.

BIO SCI D117. Movement and Health. 4 Units.
Mechanisms of movements of molecules within and across cell membranes, cytoskeleton and cell motility, muscle contraction, and physical exercises and mind-body practices. Chemical, electromagnetic, and vital energy, and regulatory pathways in such processes. Relevance to health, diseases, and integrative medicine.
Prerequisite: BIO SCI 99.

BIO SCI E117A. Exercise Sciences Seminar. 3 Units.
Students are introduced to fundamental concepts and topics in exercise science with an emphasis on developing innovative approaches for exploring the biological response to physical activity/inactivity. Interactive course with robust discussion amongst faculty and students.
Prerequisite: BIO SCI E109 and BIO SCI E112L and BIO SCI E183.

BIO SCI E117B. Exercise Sciences Seminar. 3 Units.
Students are introduced to fundamental concepts and topics in exercise science with an emphasis on developing innovative approaches for exploring the biological response to physical activity/inactivity. Interactive course with robust discussion amongst faculty and students.
Prerequisite: BIO SCI E109 and BIO SCI E112L and BIO SCI E183.

BIO SCI E117C. Exercise Sciences Seminar. 3 Units.
Students are introduced to fundamental concepts and topics in exercise science with an emphasis on developing innovative approaches for exploring the biological response to physical activity/inactivity. Interactive course with robust discussion amongst faculty and students.
Prerequisite: BIO SCI E109 and BIO SCI E112L and BIO SCI E183.

BIO SCI E118. Ecosystem Ecology. 4 Units.
A mechanistic perspective on ecosystem processes. Covers ecosystem development, element cycling, and interactions with plants and microbes. The role of ecosystems in environmental change is also addressed.
Prerequisite: BIO SCI E106 or EARTHSS 51 or EARTHSS 60A or CHEM 51C.
Same as EARTHSS 164.
Restriction: Earth System Science, Environmental Science, and Ecology and Evolutionary Biology majors have first consideration for enrollment.
Concurrent with EARTHSS 264.
BIO SCI M118L. Experimental Microbiology Laboratory. 5 Units.
Introductory general microbiology designed for preprofessional biology majors. Includes microscopy, cultivation of bacteria, morphological and biochemical characterization of bacteria, microbial metabolism, growth and genetics, microorganisms and human disease, and interactions of microorganisms with the environment. Materials fee.

Prerequisite: BIO SCI 99 and BIO SCI 100 and BIO SCI 194S.

Overlaps with BIO SCI M122L.

Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.

(lb)

BIO SCI M119. Advanced Topics in Immunology. 4 Units.
Literature-based, interactive discussions focused on review of seminal historic and recent immunology literature. Student responsibilities include reading, critical evaluation, and discussion of manuscripts.

Prerequisite: BIO SCI M121.

Restriction: Microbiology and Immunology majors have first consideration for enrollment.

BIO SCI N119. History of Neuroscience. 4 Units.
An overview of the conceptual and technical foundations of contemporary neuroscience from ancient times to the present. The subjects include synapses, neurons, brain organization, sensory, motor and regulatory systems, learning and memory, human brain function and dysfunction.

Prerequisite: BIO SCI 35 or BIO SCI N110 or PSY BEH P115D or (PSYCH 9A and PSYCH 9B and PSYCH 9C).

Restriction: Upper-division students only.

Concurrent with NEURBIO 255.

BIO SCI E120. Marine Biology . 4 Units.
Examines the biotic and abiotic factors influencing the physiology, distribution, abundances, interactions, and evolution of marine organisms and the roles of those organisms in mediating ecosystem services and functions. A field trip is required. Materials fee.

Prerequisite: BIO SCI 94.

BIO SCI M120. Signal Transduction in Mammalian Cells. 4 Units.
Introduction to major biochemical pathways that transmit information from extracellular cues into changes in cell behavior. Focuses on kinases, phosphatases, G proteins, second messengers, and protein-protein interactions. Includes discussion of primary research articles and experimental techniques.

Prerequisite: BIO SCI D103.

BIO SCI N120. Human Biology. 4 Units.
Human Biology provides an in-depth look at cutting edge topics in physiology and epidemiology as they relate to global issues of ethics, anthropology, and socioeconomics, providing the student an understanding of human health beyond basic biological function.

Prerequisite: BIO SCI 99.

Restriction: Human Biology majors only.

BIO SCI D121. Stem Cell Biology. 4 Units.
Introduces upper-level undergraduate students to stem cell biology. Include the basic biology of stem cells, potential applications of stem cells, and the ethical, legal, and moral issues associated with human stem cell research.

Prerequisite: BIO SCI D103 and BIO SCI D104.

BIO SCI M121. Immunology with Hematology. 4 Units.
Antibodies, antigens, antigen-antibody reactions, cells and tissues of lymphoreticular and hematopoietic systems, and individual and collective components of cell-mediated and humoral immune response.

Prerequisite: BIO SCI 98.
BIO SCI M121L. Advanced Immunology Laboratory. 4 Units.
Emphasis is placed on learning modern techniques in immunology such as ELISAs, western blotting, immunofluorescent staining assays. Materials fee.
Prerequisite: BIO SCI M116L and BIO SCI M121 and BIO SCI 194S. Prerequisite or corequisite: BIO SCI 100.
Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.
Concurrent with MOL BIO 221L.

(Ib)

BIO SCI M122. General Microbiology. 4 Units.
Comparative metabolism of small molecules and cell structure and relationship to microbial classification. Macromolecule synthesis and regulation, sporulation, cell division, growth, and effect of antibiotics.
Prerequisite: BIO SCI 98.

BIO SCI M122L. Advanced Microbiology Laboratory. 4 Units.
Advanced course featuring selective isolation of a wide variety of microbial types. Identification and characterization of organisms by morphological, nutritional, and biochemical approaches. Medical, industrial, and research applications. Materials fee.
Prerequisite: BIO SCI 194S. Prerequisite or corequisite: BIO SCI 100 and (BIO SCI M122 or BIO SCI M132).
Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.

(Ib)

BIO SCI M123. Introduction to Computational Biology. 4 Units.
Prerequisite: MATH 2D or MATH 2J or STATS 7 or STATS 8.
Same as COMPSCI 183.
Concurrent with MOL BIO 223.

BIO SCI D124. Biology of Integrative Medicine. 4 Units.
Presentation of biological principles and the latest clinical and basic research on complementary and alternative therapies (e.g., mind-body medicine, energy medicine, herbal medicine, acupuncture, manipulative therapies) and their integration with Western medicine. Lectures supplemented by demonstrations and hands-on learning sessions.
Overlaps with BIO SCI 9J, BIO SCI 9N.

BIO SCI E124. Infectious Disease Dynamics. 4 Units.
Discusses how the dynamical interactions between pathogens and the immune system can give rise to a variety of outcomes which include clearance of infection, persistent infection, escape from immune responses, and pathology.
Prerequisite: BIO SCI 96 or BIO SCI 97 or BIO SCI E106.

BIO SCI M124A. Virology. 4 Units.
Replication of viruses in populations, animals, and the host cell. The effects of viral infection on populations, individuals, and specific molecular effects on the target cell. Role of viral infections in cancer and degenerative diseases.
Prerequisite: BIO SCI 99.
Restriction: Biological Sciences majors only.

BIO SCI M124B. Viral Pathogenesis and Immunity. 4 Units.
The mechanisms of viral pathogenesis and of host resistance to viruses are explored in detail. HIV-1 and Influenza-A are used as examples. In each case, viral replication, cytopathic effects, immune response, and viral evasion are discussed.
Prerequisite: BIO SCI M121 or BIO SCI M124A. Recommended: BIO SCI M122.
BIO SCI M124L. Virus Engineering Laboratory. 4 Units.
An advanced laboratory for undergraduates who have completed a virology lecture class. Students learn to engineer recombinant viruses and express genes in mouse tissue.
Prerequisite: BIO SCI 194S and BIO SCI M116L and (BIO SCI M124A or BIO SCI M124B). Prerequisite or corequisite: BIO SCI 100.
Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.

(Ib)

BIO SCI M125. Molecular Biology of Cancer. 4 Units.
Molecular mechanisms of carcinogenesis. Consideration of transformation by DNA tumor viruses, RNA tumor viruses, and chemical carcinogens.
Prerequisite: BIO SCI 99.

BIO SCI M126. Learning to Read Primary Literature in Biochemistry and Molecular Biology. 4 Units.
An introduction to primary literature focusing on methods to approach, understand, and analyze scientific papers.
Prerequisite: BIO SCI 99.

BIO SCI E127. Physiological Plant Ecology. 4 Units.
An examination of the interactions between plants and their environment. Emphasis on the underlying physiological mechanisms of plant function, adaptations and responses to stress, and the basis of the distribution of plants and plant assemblages across the landscape.
Prerequisite: (EARTHSS 51) or (EARTHSS 60A and EARTHSS 60C) or (BIO SCI E106).
Same as EARTHSS 168.
Restriction: Earth System Science and Environmental Science majors have first consideration for enrollment.

BIO SCI M127L. Virology and Immunology Laboratory. 5 Units.
Introductory laboratory course in virology and immunology designed for biology majors. Curriculum includes plasmid preparation, plasmid characterization, microscopy, cell culture, transfection and infection of cells, cell counting, plaque assays, ELISA, Western blot, mixed lymphocyte reactions. Materials fee.
Corequisite: BIO SCI M121 or BIO SCI M124A.
Prerequisite: BIO SCI 99 and BIO SCI 194S and BIO SCI 100 and BIO SCI M116L.
Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.

(Ib)

BIO SCI D129. Biotechnology and Plant Breeding. 4 Units.
Conventional plant breeding techniques, their limitations, and supplementations through modern biotechnology. Includes cloning, cell transformation (genetic engineering), and cell fusion. Crop improvement, state of the art in animal and human systems, and the impact of gene technology of society.
Prerequisite: BIO SCI 94.

BIO SCI M129. Discovery of the New RNA World. 4 Units.
Focus is on RNAs role in catalysis and regulation. Topics include non-coding RNAs function in normal cells (regulation of cell homeostasis, development, and differential) and in disease (cancer, viral infection).
Prerequisite: BIO SCI 99 and (BIO SCI D103 or BIO SCI D104).

BIO SCI D130. Photomedicine. 4 Units.
Studies the use of optical and engineering-based systems (laser-based) for diagnosis, treating diseases, manipulation of cells and cell function. Physical, optical, and electro-optical principles are explored regarding molecular, cellular, organ, and organism applications.
(Design units: 0)
Prerequisite: PHYSICS 3C or PHYSICS 7D.
Same as BME 135.
Restriction: Biomedical Engineering majors have first consideration for enrollment.
BIO SCI E130. Forensic Genetics. 4 Units.
Covers techniques currently used for forensic identification and paternity testing. Topics include STR, Y-STR and mitochondrial DNA tests, database searches, mixtures, allelic drop out, likelihood ratios, laboratory errors and the interaction of science and the legal system.
Prerequisite: BIO SCI 93 and BIO SCI 94.

BIO SCI M130L. Advanced Molecular Lab Techniques. 6 Units.
Discovery-driven experimentation in the fields of molecular biology, biochemistry, and cell biology. Also involves other aspects of the lab experience including group discussion of results, scientific paper analysis, and student presentations. Materials fee.
Prerequisite: BIO SCI 100 and BIO SCI 194S and (BIO SCI D111L or BIO SCI M114L or BIO SCI M116L or BIO SCI M118L).
Repeatability: May be taken for credit 3 times.
Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.

BIO SCI E131L. Image Analysis in Biological Research. 4 Units.
Introduction to scientific image analysis including techniques such as high-speed, time-lapse, thermal imaging, and flow visualization. Students will make movies using cameras, edit and analyze images using computers, and do a writing project.
Prerequisite: (BIO SCI E106 or BIO SCI E109) and BIO SCI 100 and BIO SCI 194S.

BIO SCI M131. Innate Immunity, Infection, and Pathogenesis. 4 Units.
Role of the innate immune system in health and disease. Molecular pathways of innate immune recognition, expression and regulation of immune receptors, signal transduction, pathogen sensors, and detection of microbial ligands. Lecture and discussion of primary research articles.
Prerequisite: BIO SCI M121 and BIO SCI M122.

BIO SCI N131. Human Neurodegenerative Diseases. 4 Units.
Clinical and epidemiological aspects of neurodegenerative diseases causing dementia will be reviewed, including Alzheimer’s disease, Parkinson’s disease, Huntington’s disease, and Frontotemporal Dementia. Seminar format includes student presentation and group discussion.
Prerequisite: BIO SCI N110.

BIO SCI D132. Introduction to Personalized Medicine. 4 Units.
Introduction to the use of genomic techniques for the study of individual genomes and transcriptomes in healthy and diseased samples. Covers GWAS, current sequencing techniques, cancer genomics, and biomarker discovery.
Prerequisite: BIO SCI 99.

BIO SCI D133. Advances in Regenerative Medicine. 4 Units.
Introduces the rapidly growing field of regenerative medicine. New developments in stem cell research are discussed. Cellular, molecular, and engineering aspects of stem cell-based organ replacement strategies are examined, with emphasis on specific regenerative therapies.
Prerequisite: BIO SCI D103.
Overlaps with BIO SCI N172.

BIO SCI M133. High-Resolution Structures: NMR and X-ray. 4 Units.
Basic principles of magnetic resonance and x-ray crystallography toward the determination of high-resolution biomolecular structures.
Prerequisite: MATH 2B.
Restriction: Upper-division students only.
Concurrent with MOL BIO 211.

BIO SCI N134. Cognitive Neuroepigenetics. 4 Units.
Current topics in the emerging field of cognitive neuroepigenetics focusing on understanding the underlying epigenetic mechanisms of memory formation and persistence. Primary literature will be used to explore these processes.
Prerequisite: BIO SCI N110.
BIO SCI D135. Cell Biology of Human Disease. 4 Units.
Builds on prior biology courses about the underlying cell biological mechanisms and recent treatment advances of several model diseases. Emphasizes literature searches, reading primary literature, and student group work.
Prerequisite: BIO SCI D103.

BIO SCI E135. Molecular Evolution. 4 Units.
Introduction to the study of evolutionary change in genes and DNA sequences. Combines study of molecular biology with the study of evolution. Molecular evolution has application to many disciplines, including molecular biology, virology, systematics, and the origin of life.
Prerequisite: BIO SCI E106.

BIO SCI D136. Human Anatomy. 4 Units.
Presents a systems approach to the analysis of human structure. Molecular, cellular, tissue, organ, and organ system levels of structure and organization are integrated throughout.
Prerequisite: BIO SCI 99.
Overlaps with BIO SCI D170.

BIO SCI E136. The Physiology of Human Nutrition. 4 Units.
Examines the biochemical basis of energy metabolism, physiological processes in digestion and uptake, and the biochemical transformation of carbohydrates, fats, and proteins in the human body. The emphasis is on expanding the students' understanding of physiology.
Prerequisite: BIO SCI 98 and BIO SCI E109.
Overlaps with BIO SCI M150.

BIO SCI D137. Eukaryotic and Human Genetics. 4 Units.
Structure and function of genes in eukaryotes with emphasis on special problems of genetic studies in humans. Molecular methods of genetic analysis and gene transfer are discussed. Practical applications and ethical and social issues raised by genetic studies are addressed.
Prerequisite: BIO SCI 97. Recommended: BIO SCI 99.

BIO SCI E137. Genetics of Complex Traits. 4 Units.
Many ecologically important traits (e.g., size, age at sexual maturity) and clinical conditions are rooted in the interaction of multiple genetic loci with the environment. Theoretical and practical approaches to dissecting the genetic architecture of complex traits are explored.
Prerequisite: BIO SCI 97.

BIO SCI M137. Microbial Genetics. 4 Units.
Basic principles of microbial genetics are presented as lectures for the first half of the course. The second half is devoted to applications of these principles and requires reading review and original research papers and interactions with guest lecturers.
Corequisite: Recommended: BIO SCI 99.
Prerequisite: BIO SCI 97 and BIO SCI 98.

BIO SCI D138. Quantitative Cell Biology. 4 Units.
Builds on prior biology courses about cell biology, and works to develop a deeper understanding of experimental techniques and interpretation of experiments. A key focus will be the question of how one moves from specific examples to general.
Prerequisite: BIO SCI 99.

BIO SCI E138. Comparative Animal Physiology. 4 Units.
Maintenance aspects of physiology: water balance; feeding and digestion; metabolism; respiration and circulation.
Prerequisite: BIO SCI E109.

BIO SCI E139. Animal Sensing and Motion. 4 Units.
Explores how animals sense and respond to their environment. Includes a consideration of sensory systems, muscle physiology, and biomechanics to understand the mechanistic basis of animal behavior.
Prerequisite: BIO SCI E109.
**BIO SCI D140. How to Read a Science Paper. 4 Units.**
Provides junior and senior undergraduates currently involved or interested in pursuing research exposure to current scientific literature and training on how to read and critically evaluate primary research articles in preparation for research-oriented.

Corequisite: BIO SCI 199.
Prerequisite: BIO SCI 99.

Restriction: Upper-division students only.

**BIO SCI E140L. Evolution and the Environment Laboratory. 4 Units.**
Explores basic topics in ecology and evolutionary biology and applications to agriculture, conservation, environmental issues, and public health. Format involves lab activities and discussion of scientific journal articles, with focus on learning to evaluate scientific evidence.

Prerequisite: BIO SCI 100 and BIO SCI 194S. Prerequisite or corequisite: BIO SCI E106.

Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.

(ib)

**BIO SCI E142W. Writing/Philosophy of Biology. 4 Units.**
Philosophy of biology, e.g., scientific method in biology, the structure of evolutionary theory, teleology, ethics, and evolution. Course work includes one 4,000-word and four 1,000-word papers.

Prerequisite: Satisfactory completion of the Lower-Division Writing requirement.

Same as LPS 142W, PHILOS 142W.

Restriction: Juniors only.

(ib)

**BIO SCI M143. Human Parasitology. 4 Units.**
Introduction to human animal-parasitic diseases including worms and protozoan infections.

Prerequisite: BIO SCI 99.

**BIO SCI M144. Cell Organelles and Membranes. 4 Units.**
Structure, function, and biogenesis of biological membranes and membrane-bound organelles; protein trafficking and transmembrane signaling.

Prerequisite: BIO SCI D103.

**BIO SCI D145. Genomics, Development, and Medicine. 4 Units.**
Focuses on the applications of genomics and proteomics to problems in genetics, cell, and developmental biology. Students will gain a comprehensive understanding of the techniques currently used for genomics analysis and how best to apply these tools to solve problems.

Prerequisite: BIO SCI 99.

**BIO SCI E145. Animal Coloration and Vision. 4 Units.**
Physiological and behavioral mechanisms of color production and vision including crypsis, mimicry, aposematism, masquerade, sexual dimorphism, and predator-prey interactions through the lens of signals, receivers, and receptors; color and polarization vision in mate choice and visual adaptations to aquatic environments.

Prerequisite: Prerequisite or corequisite: BIO SCI E106.

**BIO SCI N147. Hearing and the Brain. 4 Units.**
An overview of brain mechanisms of hearing, including perception of simple sounds, speech, and music. Begins with sound itself, and looks at processing by the ear, auditory pathways, auditory cortex, and beyond. Also auditory development, learning, and clinical issues.

Prerequisite: PSYCH 160A or BIO SCI N110.

Same as PSYCH 161H.

Restriction: Cognitive Sciences, Psychology, and Biological Sciences majors have first consideration for enrollment.
BIO SCI D148. Development and Disease. 4 Units.
Development of animal embryos from a fertilized egg to a functioning organism. Topics include reproduction, body-axis formation, growth and differentiation of embryonic cells, and organogenesis, with an emphasis on congenital birth defects and diseases that disrupt these processes.
Prerequisite: BIO SCI D103 or BIO SCI D104.

BIO SCI E150. Conservation Biology. 4 Units.
Genetic and ecological issues in conservation biology, including effects of human population growth, the value of biodiversity, conservation genetics, demography, metapopulation dynamics, community and ecosystem processes, species invasions, global climate change, and reserve design and management.
Prerequisite: BIO SCI E106.

BIO SCI M150. Nutritional Biochemistry. 4 Units.
Metabolic processes of sugar and fat that lead to an understanding of diabetes, cancer, obesity and other disease states will be the focus of this course. Nutritional supplements, analysis of metabolites and mechanisms of metabolic enzymes will be covered.
Prerequisite: BIO SCI 98.
Overlaps with BIO SCI E136.

BIO SCI N150. Brain Dysfunction and Repair. 4 Units.
Introduction to the disruptions in brain function that underlie disorders such as Alzheimer's disease, Parkinsonism, schizophrenia, and depression, and the basis for drug therapies. The brain's ability to repair itself after damage and the pros and cons of that repair.
Prerequisite: BIO SCI N110.
Restriction: Neurobiology majors only.

BIO SCI E151. Population Dynamics in Ecology, Epidemiology, and Medicine. 4 Units.
Explore the dynamics of populations on an ecological, epidemiological, and medical level. Considers the dynamics of competition, predation, and parasitism; the spread and control of infectious diseases; and the in vivo dynamics of viral infections and the immune system.
Prerequisite: BIO SCI 94 or BIO SCI E106.
Concurrent with ECO EVO 251.

BIO SCI N151. Neurobiology of Aging. 4 Units.
Multidisciplinary overview of the functional capacity of the aging brain, its structural changes and the mechanisms underlying function and structure. Emphasis will be on successful brain aging and those mechanisms which lead to the development of Alzheimer's disease.
Prerequisite: BIO SCI N110.

BIO SCI N152. Developmental Neurobiology. 4 Units.
The development of the nervous system is discussed with emphasis on the processes that underlie the appearance of complex and highly ordered neural circuits. Topics include neural induction, specification, migration and death; axon growth, and neural circuit formation.
Prerequisite: BIO SCI 93.

BIO SCI D153. Molecular and Cellular Basis of Disease. 4 Units.
Provides students with examples of how human disease is usually manifested at the cellular level. The roles of specific molecules and organelles are discussed where their roles in the disease process are understood.
Prerequisite: BIO SCI D103.

BIO SCI E153. Functional and Structural Evolutionary Genomics. 4 Units.
Function and organization of genomes analyzed from an evolutionary perspective. Review of some of the most recent experimental approaches in genome analysis and comparative genomics. Relevant software to analyze DNA and expression data is used.
Prerequisite: BIO SCI 97. Recommended: BIO SCI E135 or BIO SCI E168 and (BIO SCI 7 or STATS 7 or MATH 7).
Concurrent with ECO EVO 253.
BIO SCI N153. Neuropharmacology. 4 Units.
Survey of neurotransmitter systems, focusing on how transmitters are made, how they interact with their receptors, and how drugs can influence these processes to alter neural function and behavior.
Prerequisite: BIO SCI N110.

BIO SCI E154. Genetics and Human History. 4 Units.
Explores topics in human health/history from an evolutionary perspective, with emphasis on genetics. Topics include the relationship between genetics and human disease as an evolutionary question, and how modern genetic techniques are used to study the history of human populations.
Prerequisite: Prerequisite or corequisite: BIO SCI E106.

BIO SCI N154. Molecular Neurobiology. 4 Units.
Nature and actions of genes/gene products that regulate the functioning of the nervous system and its interaction with muscles. Topics include: neural control of gene expression; genetics and molecular biology of neural and neuromuscular diseases; gene therapies for neural disorders.
Prerequisite: BIO SCI N110.

BIO SCI E155. Physiology in Extreme Environments. 4 Units.
An in-depth look at the physiological mechanisms that allow animals, including humans, to be physically active and survive in extreme environments. Physiological responses to high altitude, diving, microgravity, deserts, and extreme cold are examined.
Prerequisite: BIO SCI 94.

BIO SCI N155. Wiring the Developing Brain . 4 Units.
The development of the nervous system is discussed with particular emphasis on the processes that underlie the appearance of complex and highly ordered neural circuits. Basic neurodevelopmental processes are discussed and correlated with normal brain function/dysfunction.
Prerequisite: BIO SCI N110 or BIO SCI N152.

BIO SCI N156. Molecular Mechanisms of Memory. 4 Units.
Current topics focused on understanding the molecular mechanisms that contribute to synaptic plasticity, learning, and memory. Primary literature is used to explore the variety of molecular mechanisms underlying these processes.
Prerequisite: BIO SCI N110.

BIO SCI E157. Comparative Vertebrate Anatomy. 4 Units.
Structure and evolution of the major organ systems in vertebrates, from fish to mammals. Materials fee.
Prerequisite: BIO SCI 94.

BIO SCI N158. Neurobiology of Learning and Memory. 4 Units.
How the brain and behavior change as a result of experience, with an emphasis on identifying the neurochemical processes through which memory is stored and the parts of the brain that are involved.
Prerequisite: BIO SCI 35 or BIO SCI N110
Same as PSYCH 162A.
Restriction: Prerequisite required or Consent of instructor to enroll

BIO SCI N159. Animal Behavior. 4 Units.
Explores why animals behave the way they do from evolutionary/mechanistic perspectives. Considers selective pressures and evolutionary constraints that shape animal behavior and the underlying neural and hormonal mechanisms by using examples such as why dogs bark, why some birds migrate.
Prerequisite: BIO SCI N110.

BIO SCI E160. Biology of Birds. 4 Units.
A thorough introduction to the biology of birds, covering topics ranging from avian anatomy and physiology to behavior, natural history, ecology, genetics, evolution, systematics, and conservation. Examples from both local and global avifauna.
Corequisite: BIO SCI E161L.
Prerequisite: BIO SCI 94.
BIO SCI M160. Structure-Function Relationships of Integral Membrane Proteins. 4 Units.
Integral membrane proteins such as voltage and ligand-gated ion channels, water channels, pumps, cotransporters, and receptors (e.g., GPCRs). The emphasis is on the relationship between atomic structure and the functional properties of these proteins.

Prerequisite: BIO SCI 98 and BIO SCI 99. BIO SCI 98 with a grade of B or better. BIO SCI 99 with a grade of B or better.

Concurrent with MOL BIO 255.

BIO SCI N160. Language and the Brain . 4 Units.
Research analysis on biological bases of human linguistic capacity. Development, focusing on hemispheric specialization, plasticity; localization of specific linguistic functions in adults, with emphasis on study of aphasias; relation of linguistic capacity to general cognitive capacity, considering research on retardation.

Prerequisite: BIO SCI 35 or BIO SCI N110.

Same as PSYCH 161, LINGUIS 158.

Restriction: Psychology and Biology majors have first consideration for enrollment.

BIO SCI E161L. Biology of Birds Lab. 4 Units.
The companion to Biology of Birds (E160). Consists primarily of field trips to identify local birds and study avian natural history. Students must provide their own transportation to field sites, some with entrance fees. Students must have field binoculars.

Corequisite: BIO SCI E160.
Prerequisite: BIO SCI 100 and BIO SCI 194S.

Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.

BIO SCI E163. Environmental Microbiology. 4 Units.
Establishes a fundamental understanding of microbes living in the environment, including their distribution, diversity, and biochemistry, and discusses how they attribute to global biogeochemical cycles.

Prerequisite: (EARTHSS 53) or (EARTHSS 60A and EARTHSS 60C) or (BIO SCI E106 and BIO SCI M122).

Same as EARTHSS 170.

Concurrent with EARTHSS 270.

BIO SCI N164. Functional Neuroanatomy. 4 Units.
How neuroscience uses tools of many disciplines, from imaging to behavior, to develop and test hypotheses about functions of specific parts of the brain. Basic organization of nerve cells/vertebrate nervous system; methods of visualizing nerve cells; neural connections/activity patterns.

Prerequisite: BIO SCI N110.

BIO SCI N165. Brain Disorders and Behavior. 4 Units.
Examines the localization of human brain functions and the effects of neurological disorders on psychological functions such as perception, motor control, language, memory, and decision-making.

Prerequisite: (PSYCH 7A or PSY BEH 9) or ((PSYCH 9A or PSY BEH 11A) and (PSYCH 9B or PSY BEH 11B)) or BIO SCI 35 or BIO SCI N110.

Same as PSYCH 160D.

Restriction: Cognitive Sciences, Psychology, and Biological Sciences majors have first consideration for enrollment.

BIO SCI E166L. Field Biology. 4 Units.
Conducting group and independent studies in Southern California ecosystems, this course covers the fundamentals of experimental design, statistical analysis, communicating scientific findings (orally, visually, in writing), and other skills necessary for the scientific investigation of biological processes in the field. Materials fee.

Prerequisite: BIO SCI 100 and BIO SCI E106 and BIO SCI 194S. Satisfactory completion of the Lower-Division Writing Requirement.

(Ib)
BIO SCI N166. Introduction to Cognitive Neuroscience. 4 Units.
Introduction to the neural basis of human perceptual, motor, and cognitive abilities. Topics include sensory perception, motor control, memory, language, attention, emotion, frontal lobe function, functional brain imaging, and neuropsychological disorders.
Prerequisite: PSYCH 7A or (PSYCH 9A and PSYCH 9B) or PSY BEH 9 or (PSY BEH 11A and PSY BEH 11B) or BIO SCI 35 or BIO SCI N110
Same as PSY BEH 192L, PSYCH 160A.
Restriction: Prerequisite required or Consent of instructor to enroll

BIO SCI E168. Evolution. 4 Units.
An integrative treatment of evolutionary biology that covers evolutionary processes, basic research methods, and the history of life.
Prerequisite: BIO SCI E106.

BIO SCI D170. Applied Human Anatomy. 6 Units.
Systems approach to analyze the form and function of the human body with an emphasis on applying anatomical concepts to evaluate clinical cases. The laboratory will use human models and a simulated cadaver dissection for structure. Materials fee.
Prerequisite: BIO SCI E109 or PHRMSCI 120. BIO SCI E109 with a grade of C or better. PHRMSCI 120 with a grade of C or better.
Overlaps with BIO SCI D136.

BIO SCI E170. Mechanical Physiology. 4 Units.
Explores the mechanics of animal physiology. Basic biomechanical principles are introduced and illustrated in a variety of physiological systems. Topics include the fluid and structural mechanics of muscles, skeletons, circulation, insect flight, biomaterials, and fish swimming.
Prerequisite: BIO SCI E109.

BIO SCI E172. Plant Diversity in a Changing World. 4 Units.
Investigation of planet diversity in California and throughout the world, including basic systematic concepts, an introduction to major groups of flowering plants, and the effects of global biological change on plant diversity.
Prerequisite: BIO SCI E106.
Concurrent with ECO EVO 272.

BIO SCI E172L. Plant Systematics Laboratory. 4 Units.
Diversity of flowering plants is investigated in the laboratory and field. Familiarity with flowering plant families, particularly those prominent in the California flora, is emphasized.
Prerequisite: BIO SCI E106 and BIO SCI 100 and BIO SCI 194S. Prerequisite or corequisite: BIO SCI E172.
Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.
Concurrent with ECO EVO 273.

(Ib)

BIO SCI N172. Regenerative Neurobiology. 4 Units.
Explores the field of regenerative neurobiology. Both basic stem cell discoveries and their potential clinical application to brain disorders examined. Opportunities, challenges, and implications of this research also discussed.
Prerequisite: BIO SCI N110.
Overlaps with BIO SCI 44, BIO SCI D133.

BIO SCI N173. Human Neuropsychology. 4 Units.
A survey of human brain disorders using a clinical case study approach to illustrate fundamental issues in studying brain and behavior. Topics include sensory deficits, attentional neglect, amnesia, cortical organization, clinical psychopathology, and more.
Prerequisite: BIO SCI N110 OR PSYCH 9A OR PSY BEH 11A.
Same as PSY BEH 163C, PSYCH 162N.
Restriction: School of Biological Sciences majors, Cognitive Sciences, Psychology, and Psychology and Social Behavior majors have first consideration for enrollment.
BIO SCI N174. Principles of Neural Computation. 4 Units.
Introduction to the theoretical principles and biological mechanisms underlying how brains acquire, assimilate, store, and retrieve information, and how they compute adaptive responses to external inputs.
Prerequisite: BIO SCI N110.

BIO SCI E175. Restoration Ecology. 4 Units.
Prerequisite: Prerequisite or corequisite: BIO SCI E106.

BIO SCI E176. Evolution of Infectious Disease. 4 Units.
Introduction to the major human pathogens, and the ecological and evolutionary processes affecting their impact on public health. Topics include the evolution of drug resistance, problems in vaccine development, diseases emerging from animals, and bioterrorism.
Prerequisite: BIO SCI 94.

BIO SCI N176. Cerebral Cortex: Structure, Function, and Plasticity. 4 Units.
The cerebral cortex is highly developed in mammals and is responsible for higher perceptual and cognitive functions. The course explores some amazing aspects of cortical structure, function, and plasticity emphasizing primary literature.
Prerequisite: BIO SCI N110.

BIO SCI E179. Limnology and Freshwater Biology. 4 Units.
Biology of freshwater environments: lakes, ponds, rivers, their biota, and the factors which influence distribution of organisms.
Prerequisite: BIO SCI 94.

BIO SCI E179L. Field Freshwater Ecology. 4 Units.
Analytical techniques for common water-quality variables of lakes, streams, rivers. Benthic fauna, vertebrates and invertebrates, algae, and aquatic plants. Emphasis on field methods with an experimental approach; laboratory exercises. Field trips to marshes, vernal pools, rivers and streams. Materials fee.
Corequisite: BIO SCI E179.
Prerequisite: BIO SCI 100 and BIO SCI 194S. Prerequisite or corequisite: BIO SCI E179.
Restriction: Students who require this lab for completion of their degree have first consideration for enrollment.

BIO SCI M180. Biotechnological Applications of Energy and Environmental Research. 4 Units.
Covers microbiological and biochemical background related to current biotechnological applications, case studies of biotech-companies, and basic information related to patents and start-up companies. Topics include biofuel, bioremediation, agricultural and environmental applications.
Prerequisite: BIO SCI M122.

BIO SCI E181. Conservation in the American West. 4 Units.
Critical examination of contemporary conservation issues in the American West, with particular attention to water in California, grazing on public lands, and species decline and extinctions.
Prerequisite: BIO SCI E106.

BIO SCI E182. Mediterranean Ecosystems: Biodiversity and Conservation. 4 Units.
Biodiversity, history of human impacts, and conservation efforts are examined in the five Mediterranean-type ecosystems. Remaining natural habitat, approaches to ecological habitat restoration, control of exotic species, and predicted consequences of global climate change are described. Field trip required.
Prerequisite: BIO SCI 94.
**BIO SCI N182. Vision. 4 Units.**
Visual perception and the anatomy and physiology of the visual system. Topics include the retina and the visual pathway; visual sensitivity; color vision; spatial vision; motion perception; and the development of the visual system.

Same as PSYCH 131A.
Overlaps with PSYCH 130A.

Restriction: Upper-division students only. Psychology, Cognitive Sciences, and Biological Sciences majors have first consideration for enrollment.

**BIO SCI E183. Exercise Physiology. 4 Units.**
Focus upon critical topics in the area of exercise biology using the comparative physiological approach. Specifically examine the physiological factors that limit the capacity of an organism to sustain high levels of aerobic metabolism.

Prerequisite: BIO SCI 98 and BIO SCI E109.

**BIO SCI E184. Ecology and Diversity of Insects. 4 Units.**
Insects—representing two-thirds of all species—play fundamental roles in human health, agriculture, and natural ecosystems. Topics include insect morphology, development, physiology, taxonomy, ecology, and insects in human affairs. Lecture includes interactive demonstrations and an optional weekend trip. Materials fee.

Prerequisite: BIO SCI E106.

**BIO SCI E186. Population and Community Ecology. 4 Units.**
Population structure, function, development, and evolution. Topics include population structure, population growth and regulation, metapopulations, predation, competition, species diversity, ecosystem function, macroecology, and island biogeography. Offered every other Winter.

Prerequisite: BIO SCI E106.

**BIO SCI E188. Introduction to Insect Physiology. 4 Units.**
Physiology of insects. Insect respiration, digestion, excretion, and neurobiology, including sensory systems and effectors.

Prerequisite: BIO SCI E109.

**BIO SCI E189. Environmental Ethics. 4 Units.**
History of evolution of environmental ethics in America. Management problems in national parks, wilderness areas, wild and scenic rivers, national forests. Contemporary and historical aspects/contributors to the field. Mitigation, endangered species, habitat restoration, biodiversity, and environmental activism. Field trips required.

Restriction: Upper-division students only.

**BIO SCI 190. Transfer Student Seminar. 1 Unit.**
Weekly meetings consisting of presentations by faculty, professional staff, and New Student Peer Academic Advisors provide information about the School of Biological Sciences, campus resources, and special programs/opportunities.

Grading Option: Pass/no pass only.

Restriction: New transfer students only.

**BIO SCI D190. Topics in Developmental and Cell Biology. 2-4 Units.**
Studies in selected areas of developmental and cell biology.

Prerequisite: BIO SCI D103.

Repeatability: May be taken for credit 3 times as topics vary.

Restriction: School of Biological Sciences majors only. Upper-division students only.

**BIO SCI E190. Topics in Ecology and Evolutionary Biology. 2-4 Units.**
Studies in selected areas of ecology and evolutionary biology.

Prerequisite: BIO SCI E106.

Repeatability: May be taken for credit 3 times as topics vary.
BIO SCI M190. Topics in Molecular Biology and Biochemistry. 2-4 Units.
Studies in selected areas of Molecular Biology and Biochemistry.

Prerequisite: BIO SCI 98.

Repeatability: May be taken for credit 3 times as topics vary.

BIO SCI N190. Topics in Neurobiology and Behavior. 2-4 Units.
Studies in selected areas of neurobiology and behavior.

Prerequisite: BIO SCI N110.

Repeatability: May be taken for credit 3 times as topics vary.

BIO SCI 191A. Senior Seminar on Global Sustainability I. 2 Units.
Students attend weekly seminar to discuss current issues in global sustainability. Weekly attendance at Global Sustainability Forum also is required. Seminar utilized to analyze forum presentations. Prepare bibliography.

Grading Option: In progress only.

Same as SOCECOL 186A, EARTHSS 190A.

Restriction: Seniors only. Global Sustainability minors have first consideration for enrollment.

BIO SCI 191B. Senior Seminar on Global Sustainability II. 2 Units.
Students attend weekly seminar to discuss current issues in global sustainability. Weekly attendance at Global Sustainability Forum also is required. Seminar utilized to analyze forum presentations. Prepare research proposal.

Prerequisite: BIO SCI 191A or SOCECOL 186A or EARTHSS 190A.

Grading Option: In progress only.

Same as SOCECOL 186B, EARTHSS 190B.

Restriction: Seniors only.

BIO SCI 191CW. Writing/Senior Seminar on Global Sustainability III. 4 Units.
Students attend weekly seminar to discuss current issues in global sustainability. Weekly attendance at Global Sustainability Forum also is required. Seminar utilized to analyze Forum presentations and to prepare senior research paper. Prepare/write research paper under direction of faculty member.

Prerequisite: BIO SCI 191B or EARTHSS 190B or SOCECOL 186B. Satisfactory completion of the Lower-Division Writing requirement.

Same as EARTHSS 190CW, SOCECOL 186CW.

Restriction: Seniors only.

(Ib)

BIO SCI 192. Tutoring in Biology. 2 Units.
Tutoring program with Biological Sciences student peers.

Repeatability: May be taken for credit 6 times.

Restriction: Biological Sciences Peer Tutoring Program students only.

BIO SCI 194. Current Topics in Biology. 1 Unit.
A seminar designed to discuss recent research findings and experimental issues in biology.

Corequisite: BIO SCI 199.

Grading Option: Pass/no pass only.

Repeatability: Unlimited as topics vary.

BIO SCI 194S. Safety and Ethics for Research. 1 Unit.
Introduces students to the concepts, techniques, and ethics involved in biological sciences laboratory work.

Grading Option: Pass/no pass only.
BIO SCI H195. Honors Topics in Biological Sciences. 4 Units.
Varied course topics in Biological Sciences designed for students in Honors in Biological Sciences.
Restriction: Acceptance to the Biological Sciences Honors Program.

BIO SCI 197. Special Study in Biological Sciences. 1-5 Units.
Individualized instruction dealing with conceptual or theoretical problems in the biological sciences, rather than technical problems.
Prerequisite: BIO SCI 94 and BIO SCI 194S.
Repeatability: May be repeated for credit unlimited times.
Restriction: Maximum of 5 units (per quarter) between BIO SCI 197, BIO SCI 198, and BIO SCI 199.

BIO SCI 198. Directed Group Studies. 1-5 Units.
Small group experimental laboratory or field work performed under the direction of a faculty member.
Prerequisite: BIO SCI 94 and BIO SCI 194S.
Repeatability: May be repeated for credit unlimited times.

BIO SCI 199. Independent Study in Biological Sciences Research. 1-5 Units.
Individual experimental laboratory or field research under a professor's direction. Required for participation in the Excellence in Research Program.
Prerequisite: BIO SCI 194S and BIO SCI 94.
Repeatability: Unlimited as topics vary.

Developmental and Cell Biology Courses

DEV BIO 200A. Research in Developmental and Cell Biology. 2-12 Units.
Independent research with Developmental and Cell Biology faculty.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

DEV BIO 200B. Research in Developmental and Cell Biology. 2-12 Units.
Independent research with Developmental and Cell Biology faculty.
Prerequisite: DEV BIO 200A.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

DEV BIO 200C. Research in Developmental and Cell Biology. 2-12 Units.
Independent research with Developmental and Cell Biology faculty.
Prerequisite: DEV BIO 200B.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

DEV BIO 200R. Research in Developmental & Cell Biology for First-year Students. 2-12 Units.
Independent research within the laboratories of graduate training faculty in the Department of Developmental and Cell Biology for first-year Ph.D. students.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be taken for credit 3 times.

DEV BIO 201A. Advanced Topics in Developmental Biology. 2 Units.
Advanced study in various fields of organismic biology.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.
DEV BIO 203A. Graduate Tutorial in Developmental and Cell Biology. 4 Units.
Advanced study in areas not represented by formal courses. May involve individual or small group study through discussion, reading, and composition. Time and subject matter arranged individually.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

DEV BIO 203B. Graduate Tutorial in Developmental and Cell Biology. 4 Units.
Advanced study in areas not represented by formal courses. May involve individual or small group study through discussion, reading, and composition. Time and subject matter arranged individually.
Prerequisite: DEV BIO 203A.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

DEV BIO 203C. Graduate Tutorial in Developmental and Cell Biology. 4 Units.
Advanced study in areas not represented by formal courses. May involve individual or small group study through discussion, reading, and composition. Time and subject matter arranged individually.
Prerequisite: DEV BIO 203B.
Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

DEV BIO 206A. Developmental and Cell Biology Journal Club. 2 Units.
Advanced study of various topics in cell biology.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.

DEV BIO 206B. Developmental and Cell Biology Journal Club. 2 Units.
Advanced study of various topics in cell biology.
Prerequisite: DEV BIO 206A.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.

DEV BIO 206C. Developmental and Cell Biology Journal Club. 2 Units.
Advanced study of various topics in cell biology.
Prerequisite: DEV BIO 206B.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.

DEV BIO 207. Mouse Developmental Genetics. 4 Units.
Introduction to using the mouse in contemporary biomedical research. The biology and development of the laboratory mouse, methods for manipulation of the mouse genome and embryos, and examples of application of these methods to understand mammalian development and homeostasis.
Same as BIOCHEM 215.
Restriction: Graduate students only.

DEV BIO 208. Balancing the Academic Workload. 2 Units.
Students receive formal training in pedagogy and balancing graduate-level biology research with concurrent teaching commitment. Recommended for graduate students who have an active research program and are teaching in the same quarter.
DEV BIO 209. Molecular Genetics Journal Club. 2 Units.
Advanced topics of current interest in molecular and developmental genetics.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.

DEV BIO 210. Advanced Developmental Genetics. 4 Units.
Focuses on discussion of critical concepts in developmental biology and regeneration, with emphasis on model organisms such as Drosophila, Zebrafish, and murine systems. Molecular mechanisms underlying key developmental decisions also discussed.
Repeatability: May be taken for credit 2 times.
Restriction: Graduate students only.

DEV BIO 212. Topics in Systems Biology. 2 Units.
Studies in selected areas of Systems Biology.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.

DEV BIO 213. Scientific Skills . 2 Units.
Addresses and promotes the development of essential skills required in scientific and research careers, including scientific writing, effective presentation and communication, and mentoring skills.
Grading Option: Satisfactory/unsatisfactory only.
Restriction: Graduate students only.

DEV BIO 214. Principles of Genomics. 4 Units.
A survey course of the principal subfields of genomics and their applications to biological and health sciences that will cover genome assembly and annotation, genome structure, comparative genomics, population genomics, functional genomics, and medical genomics.
Restriction: Graduate students only.

DEV BIO 231B. Cell Biology. 4 Units.
A broadly based course including topics in extracellular matrix, cytoskeleton, organelle biogenesis, receptor-mediated endocytosis, signal transduction, cell cycle, and developmental biology.
Concurrent with BIO SCI D154.

DEV BIO 232. Systems Cell and Developmental Biology. 4 Units.
Introduces concepts needed to understand cell and developmental biology at the systems level, i.e., how the parts (molecules) work together to create a complex output. Emphasis on using mathematical/computational modeling to expand/modify insights provided by intuition.
Same as BME 213.
Restriction: Graduate students only.

DEV BIO 245. Stem Cell Biology. 4 Units.
The basic characteristics and development roles of embryonic, adult, and cancer stem cells in the human body and in model systems and the use of experimental and genetic methods to analyze and manipulate their properties.
Restriction: Graduate students only.

DEV BIO 290A. Colloquium in Developmental and Cell Biology. 2 Units.
Contemporary research problems. Research students, faculty, and other invited speakers introduce research and review topics.
Restriction: Graduate students only.
DEV BIO 290B. Colloquium in Developmental and Cell Biology. 2 Units.
Contemporary research problems. Research students, faculty, and other invited speakers introduce research and review topics.

Prerequisite: DEV BIO 290A.

Restriction: Graduate students only.

DEV BIO 290C. Colloquium in Developmental and Cell Biology. 2 Units.
Contemporary research problems. Research students, faculty, and other invited speakers introduce research and review topics.

Prerequisite: DEV BIO 290B.

Restriction: Graduate students only.

DEV BIO 292A. Scientific Communication. 2 Units.
Small group meetings for graduate students to practice scientific writing, debate, and presentation skills.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

DEV BIO 292B. Scientific Communication. 2 Units.
Small group meetings for graduate students to practice scientific writing, debate, and presentation skills.

Prerequisite: DEV BIO 292A.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

DEV BIO 292C. Scientific Communication. 2 Units.
Small group meetings for graduate students to practice scientific writing, debate, and presentation skills.

Prerequisite: DEV BIO 292B.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

DEV BIO 293. Seminar in Interactive Teaching in Biology. 2 Units.
Students receive formal training in use and assessment of interactive teaching strategies in university-level biology classes. Additional aspects of course design and implementation are covered. Recommended for graduate students who have or will be teaching discussion sections.

Repeatability: May be taken for credit 2 times.

DEV BIO 399. University Teaching. 4 Units.
Limited to Teaching Assistants.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

Ecology and Evolutionary Biology Courses

ECO EVO 200A. Research in Ecology and Evolutionary Biology. 2-12 Units.
Individual research with Ecology and Evolutionary Biological faculty.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

ECO EVO 200B. Research in Ecology and Evolutionary Biology. 2-12 Units.
Individual research with Ecology and Evolutionary Biological faculty.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.
ECO EVO 200C. Research in Ecology and Evolutionary Biology. 2-12 Units.
Individual research with Ecology and Evolutionary Biological faculty.

Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

ECO EVO 201. Seminar in Ecology and Evolutionary Biology. 2 Units.
Invited speakers, graduate students, and faculty present current research in ecology and evolutionary biology.

Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.

Concurrent with BIO SCI E107.

ECO EVO 203A. Graduate Tutorial in Ecology and Evolutionary Biology. 2-12 Units.
Advanced study in areas not represented by formal courses. May involve individual or small group study through reading, discussion, and composition.

Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

ECO EVO 203B. Graduate Tutorial in Ecology and Evolutionary Biology. 2-12 Units.
Advanced study in areas not represented by formal courses. May involve individual or small group study through reading, discussion, and composition.

Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

ECO EVO 203C. Graduate Tutorial in Ecology and Evolutionary Biology. 2-12 Units.
Advanced study in areas not represented by formal courses. May involve individual or small group study through reading, discussion, and composition.

Repeatability: Unlimited as topics vary.
Restriction: Graduate students only.

ECO EVO 204. Writing Grant Proposals. 4 Units.
Provides students with hands-on experience writing proposals in the research areas of ecology, evolution, or physiology.

Restriction: Graduate students only.

ECO EVO 205. Special Topics in Ecology. 4 Units.
Survey of special topics in Ecology.

Restriction: Graduate students only.

ECO EVO 206. Special Topics in Evolution. 4 Units.
Extensive introduction to the primary literature of evolutionary biology. Topics include population genetics, quantitative genetics, neutralism, molecular evolution, evolution of genetic systems, genetic architecture of fitness, speciation, and macroevolution.

Restriction: Graduate students only.

ECO EVO 207. Quantitative Methods in Ecology and Evolutionary Biology. 4 Units.
Statistics for ecologists and evolutionary biologists. Emphasis on specific applications and underlying assumptions rather than on methods of calculation. Topics include experimental design, parametric and nonparametric methods, analysis of variance and covariance, and multiple regression.

Prerequisite: Completion of at least one quarter of statistics including regression and analysis of variance.

Restriction: Graduate students only.

ECO EVO 208. Ecological and Evolutionary Physiology. 4 Units.
A summary of information in organismal biology, comparative and ecological physiology, and the biophysical basis of organismal function. Course offered every other fall.

Restriction: Graduate students only.
ECO EVO 210. Foundations of Physiology. 4 Units.
Physical and functional principles common to many living forms. Course forms a basis for subsequent specialization in any of the subdisciplines of physiology. Course offered in even years.

Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.

ECO EVO 218. Advanced Topics in Evolutionary Biology. 4 Units.
Content and instructor will vary from quarter to quarter. Possible topics include quantitative genetics, experimental methods of evolutionary studies, mathematical modeling in evolutionary studies, and the evolution of genetic systems.

Repeatability: May be repeated for credit unlimited times.

ECO EVO 219. Advanced Topics in Ecological Genetics. 4 Units.
Content and instructor will vary from year to year. Possible topics include coevolution, sex-ratio evolution, evolution senescence, plant population biology, and density-dependent selection.

Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.

ECO EVO 221. Advanced Topics in Ecology. 2-4 Units.
Weekly discussion of current topics in ecology at the graduate level.

Grading Option: Satisfactory/unsatisfactory only.
Repeatability: Unlimited as topics vary.

ECO EVO 227. Plant Physiological Ecology. 4 Units.
Provides a summary of information on plant organismal biology, comparative and ecological physiology, and functional ecology. Offered every other fall.

Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.

ECO EVO 228. Seminar in Conservation Biology. 2 Units.
Devoted to the application of basic ecological principles to the understanding and resolution of environmental problems of both local and global natures. Current problems approached through a combination of readings, group discussions, and visiting speakers.

Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.

ECO EVO 230. Topics in Microbial Ecology. 2-4 Units.
Weekly discussion of current topics in ecology, biogeochemistry, evolution, and physiology of microbial organisms.

Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.

ECO EVO 235. Experimental Evolution. 2 Units.
Explores experimental evolution, which is now a well-established part of evolutionary biology. With the advent of genomics, it is now one of the most powerful tools for studying the genetic foundations of biology.

Prerequisite: BIO SCI E106.

Repeatability: May be repeated for credit unlimited times.
Restriction: Biological Sciences graduate students only.
ECO EVO 246. Seminar in Ecology and Evolution Education. 2 Units.
Weekly discussion of teaching techniques and challenges that are specific to courses in ecology and evolutionary biology. Emphasis will be on using evidence-based pedagogy techniques. There will be a combination of readings, group discussions and speakers.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

ECO EVO 251. Population Dynamics in Ecology, Epidemiology, and Medicine. 4 Units.
Explore the dynamics of populations on an ecological, epidemiological, and medical level. Considers the dynamics of competition, predation, and parasitism; the spread and control of infectious diseases; and the in vivo dynamics of viral infections and the immune system.

Restriction: Graduate students only.

Concurrent with BIO SCI E151.

ECO EVO 253. Functional and Structural Evolutionary Genomics. 4 Units.
Function and organization of genomes analyzed from an evolutionary perspective. Review of some of the most recent experimental approaches in genome analysis and comparative genomics. Relevant software to analyze DNA and expression data is used.

Concurrent with BIO SCI E153.

ECO EVO 272. Plant Diversity in a Changing World. 4 Units.
Investigation of plant diversity in California and throughout the world, including basic systematic concepts, introduction to major groups of flowering plants, and the effects of global biological change on plant diversity. Students carry out a phylogenetic analysis using appropriate software.

Concurrent with BIO SCI E172.

ECO EVO 273. Plant Systematics Laboratory. 4 Units.
Diversity of flowering plants is investigated in the laboratory and field. Familiarity with flowering plant families, particularly those prominent in the California flora, is emphasized.

Concurrent with BIO SCI E172L.

ECO EVO 285. Topics in Evolutionary Genetics. 2 Units.
Weekly discussion of recent research on evolutionary genetics.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

ECO EVO 287. Communicating Research Through Video. 4 Units.
Students explore videography to develop basic production skills through practice with high interest special topics, such as laboratory experimental evolution and educational interdisciplinary field events, and then develop media to communicate their own research or other topics of interest.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

ECO EVO 288. Documenting Research Through Cinematic Production. 4 Units.
Students gain advanced media expertise by conceptualizing investigative research into publicly engaging video projects. Popularly accessible research topics will be adapted into documentary, television, or cinematic pieces that provide opportunities for developing professionally marketable skills in educationally effective media production.

Prerequisite: ECO EVO 287.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.

ECO EVO 299. Independent Study. 1-4 Units.
Individual research or investigation under the direction of an individual faculty.

Grading Option: Satisfactory/unsatisfactory only.
ECO EVO 323. Curriculum and Methods for Elementary School Science. 4 Units.
Prospective elementary teachers learn how to teach science in grades K-8. Covers States science requirements, a variety of teaching methods, criteria for selecting science curriculum materials, and how to plan science lessons, units, experiments, projects, and demonstrations.

Same as EDUC 323.

ECO EVO 341. Teaching Science in Secondary School. 4 Units.
Prospective secondary science teachers learn how to teach science in grades 7-12. Covers State science requirements, a variety of teaching methods, criteria for selecting science curricular materials, and how to plan science lessons, units, experiments, projects, and demonstrations.

Same as EDUC 341.

Restriction: Teacher Credential Program students only.

ECO EVO 344. Applied Instructional Strategies in Secondary School Sciences. 4 Units.
Application of pedagogy and research to practice science teaching experiences in the secondary schools. A continuation of the Education 340 series with an emphasis on the needs of students with culturally diverse backgrounds.

Repeatability: May be taken for credit 2 times.

Same as EDUC 344.

Restriction: Teacher Credential Program students only.

ECO EVO 398. Teaching Assistant Seminar. 2 Units.
Readings, lectures, workshops, and student presentations designed to help develop teaching skills of graduate students teaching university-level biology classes. Topics vary and may include: course organization, presentation styles, exam design, grading, motivating students, and commonly encountered problems.

Repeatability: May be repeated for credit unlimited times.

ECO EVO 399. University Teaching. 4 Units.
Mandatory course for Ecology and Evolutionary Biology Teaching Assistants, required in each quarter in which student has a Teaching Assistant position. Limited to Teaching Assistants.

Repeatability: May be repeated for credit unlimited times.

Molecular Biology and Biochemistry Courses

MOL BIO 200A. Research in Molecular Biology and Biochemistry. 2-12 Units.
Individual research with Molecular Biology and Biochemistry faculty.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

MOL BIO 200B. Research in Molecular Biology and Biochemistry. 2-12 Units.
Individual research with Molecular Biology and Biochemistry faculty.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

MOL BIO 200C. Research in Molecular Biology and Biochemistry. 2-12 Units.
Individual research with Molecular Biology and Biochemistry faculty.

Repeatability: Unlimited as topics vary.

Restriction: Graduate students only.

MOL BIO 200R. Research in Developmental & Cell Biology for First-year Students. 2-12 Units.
Independent research within the laboratories of graduate training faculty in the Department of Molecular Biology and Biochemistry for first-year Ph.D. students.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be taken for credit 3 times.
MOL BIO 201A. Seminars in Molecular Biology & Biochemistry. 2 Units.
Presentation of research from department laboratories or, when pertinent, of other recent developments.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.

MOL BIO 201B. Seminars in Molecular Biology & Biochemistry. 2 Units.
Presentation of research from department laboratories or, when pertinent, of other recent developments.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.

MOL BIO 201C. Seminars in Molecular Biology & Biochemistry. 2 Units.
Presentation of research from department laboratories or, when pertinent, of other recent developments.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.

MOL BIO 202A. Tutorial in Molecular Biology and Biochemistry. 2 Units.
Tutorials in the area of research of a particular professor which relate current research to the literature. May be conducted as journal clubs.
Repeatability: Unlimited as topics vary.

MOL BIO 202B. Tutorial in Molecular Biology and Biochemistry. 2 Units.
Tutorials in the area of research of a particular professor which relate current research to the literature. May be conducted as journal clubs.
Repeatability: Unlimited as topics vary.

MOL BIO 202C. Tutorial in Molecular Biology and Biochemistry. 2 Units.
Tutorials in the area of research of a particular professor which relate current research to the literature. May be conducted as journal clubs.
Repeatability: Unlimited as topics vary.

MOL BIO 203. Nucleic Acid Structure and Function. 4 Units.
Structure and chemistry of nucleic acids. Relationship between these properties and the mechanisms of fundamental processes such as replication and repair, RNA-mediated catalysis, formation and regulation of higher order chromatin structure and recombination.
Prerequisite: BIO SCI 98 and BIO SCI 99 and CHEM 51A and CHEM 51B and CHEM 51C.

MOL BIO 204. Protein Structure and Function. 4 Units.
The structure and properties of proteins, enzymes, and their kinetic properties.
Prerequisite: BIO SCI 98 and BIO SCI 99 and CHEM 51C.

MOL BIO 205. Molecular Virology. 4 Units.
Primary research data on the major DNA and RNA viruses emphasizing strategies of regulation of gene expression. Utilization of viruses as molecular biological tools. Graduate-level knowledge of the biochemistry and molecular biology of macromolecules is required.
Prerequisite: MOL BIO 203 and MOL BIO 204.
Restriction: Graduate students only.

MOL BIO 211. High-Resolution Structures: NMR and X-ray. 4 Units.
Basic principles of magnetic resonance and x-ray crystallography toward the determination of high-resolution biomolecular structures.
Prerequisite: MATH 2B.
Restriction: Graduate students only.
Concurrent with BIO SCI M133.
MOL BIO 213. Literature in Nucleic Acid Structure and Function. 2 Units.
Exploration and critical analysis of recent primary scientific literature in structure, properties, and biological mechanisms involving nucleic acids.
Corequisite: MOL BIO 203.
Grading Option: Satisfactory/unsatisfactory only.

MOL BIO 214. Literature in Protein Structure and Function. 2 Units.
Exploration and critical analysis of recent primary scientific literature in structure and properties of proteins, enzymes, and their kinetic properties.
Corequisite: MOL BIO 204.
Grading Option: Satisfactory/unsatisfactory only.

MOL BIO 215. Integrative Immunology. 4 Units.
Lectures and student presentations of primary literature. The main goal is to achieve a basic understanding of the cellular and molecular basis of innate and adaptive immunity, and how immune function is coordinated at a systems level.
Same as M&MG 215.

MOL BIO 217A. Principles of Cancer Biology I. 4 Units.
Oncogenes and tumor suppressor genes are studied from molecular viewpoints. Also studies their role in cancer; viral carcinogenesis. Designed for graduate students interested in cancer research. Format includes lectures and student-led discussions.
Prerequisite: MOL BIO 203 and MOL BIO 204.
Restriction: Graduate students only.

MOL BIO 217B. Principles of Cancer Biology II. 4 Units.
Topics include cancer cell growth and metastasis, chemical carcinogenesis, and cancer genetics and epidemiology. Designed for graduate students interested in cancer research. Format includes lectures and student-led discussions.
Prerequisite: MOL BIO 203 and MOL BIO 204.
Restriction: Graduate students only.

MOL BIO 218. Clinical Cancer. 3 Units.
Designed to acquaint students in basic life science with clinical cancer.
Restriction: Graduate students and Postdocs only.

MOL BIO 220. Structure & Synthesis of Biological Macromolecules Journal Club. 2 Units.
Advanced topics in macromolecular structure and synthesis as related to biological problems.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: May be repeated for credit unlimited times.
Restriction: Graduate students only.

MOL BIO 221. Advanced Topics in Immunology. 4 Units.
Literature-based, interactive discussions focused on review of seminal historic and recent immunology literature. Student responsibilities include reading, critical evaluation, and discussion of manuscripts.
Prerequisite: M&MG 215.
Restriction: Graduate students only.

MOL BIO 221L. Advanced Immunology Laboratory. 4 Units.
An advanced course in immunology for graduate students enrolled in the Biotechnology master's program. Emphasis is placed on learning modern techniques in immunology such as ELISAs, western blotting, immunofluorescent staining assays.
Restriction: Graduate students only.
Concurrent with BIO SCI M121L.
MOL BIO 223. Introduction to Computational Biology. 4 Units.

Same as BME 232.

Restriction: Graduate students only.

Concurrent with BIO SCI M123 and COMPSCI 183.

MOL BIO 224. Virus Engineering Laboratory. 4 Units.
An advanced laboratory for graduate students enrolled in the Biotechnology master's program. Students learn to engineer recombinant eukaryotic viruses and express genes in mouse tissue.

Restriction: Graduate students only.

MOL BIO 227. Immunology Journal Club. 2 Units.
Advanced topics in immunology as related to an understanding of human disease.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be taken for credit 15 times.

Restriction: Graduate students only.

MOL BIO 227L. Virology and Immunology Laboratory. 5 Units.
Introductory laboratory course in virology and immunology designed for Biological Sciences graduate students. Curriculum includes plasmid preparation, plasmid characterization, microscopy, cell culture, transfection and infection of cells, cell counting, plaque assays, ELISA, Western blot, mixed lymphocyte reactions.

Restriction: Graduate students only.

MOL BIO 228. Genetic Engineering and Biotechnology. 4 Units.
An advanced course in genetic engineering and biotechnology for graduates enrolled in the Biotechnology Master's Program. Emphasis will be placed on learning advanced methods in assembling the gene for expression in bacteria, yeast and human cells.

Restriction: Graduate students only.

MOL BIO 229. Research-in-Progress Seminars. 1 Unit.
Two half-hour presentations by graduate students and postdoctorals to the department on their current research projects.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be taken for credit 15 times.

Restriction: Graduate students only.

MOL BIO 250. Advanced Topics in Biotechnology - Nucleic Acids. 2 Units.
Supplements laboratory curriculum with scientific background behind experimental methods. Format consists of lectures and the presentation and analysis of relevant papers from the scientific literature.

Corequisite: MOL BIO 250L.

Restriction: Biotechnology graduate students only.

MOL BIO 250L. Biotechnology Laboratory - Nucleic Acids. 8 Units.
Nucleic acid techniques and recombinant DNA technology. Extraction and purification of nucleic acids, cloning and subcloning, PCR, site-directed mutagenesis, nucleic acid hybridization, additional associated procedures. Students must demonstrate accurate documentation of data (laboratory notebook) detailing experience and results.

Corequisite: MOL BIO 250.

Restriction: Biotechnology graduate students only.
MOL BIO 251. Advanced Topics in Biotechnology - Protein Purification and Characterization. 2 Units.
Supplements laboratory curriculum with scientific background behind experimental methods. Format consists of lectures and the presentation and analysis of relevant papers from the scientific literature.

Corequisite: MOL BIO 251L.
Prerequisite: MOL BIO 250L and MOL BIO 250.

Restriction: Biotechnology graduate students only.

MOL BIO 251L. Biotechnology Laboratory - Protein Purification and Characterization. 8 Units.
Major techniques of handling proteins and antibodies. Protein engineering, expression and large-scale purification of recombinant proteins from bacteria, HPLC, antibody purification, western blotting, additional associated procedures. Students must demonstrate accurate documentation of data (laboratory notebook) detailing experience and results.

Corequisite: MOL BIO 251.
Prerequisite: MOL BIO 250L and MOL BIO 250.

Restriction: Biotechnology graduate students only.

MOL BIO 252L. Biotechnology Management Laboratory. 8 Units.
Overview of current methods in biotechnology, designed specifically for biotechnology graduate students. Organized into four distinct sections (nucleic acids, proteins, virology, and immunology). Students must demonstrate accurate documentation of data (laboratory notebooks) detailing experience and results.

Restriction: Biotechnology graduate students only.

MOL BIO 253. Biotech Management . 5 Units.
Taught jointly by Biological Sciences and Merage School faculty, the course addresses fundamental aspects within, and associated with, the biotechnology industry. Curriculum is focused largely on management issues, including finance, product development, pharmaceuticals, project management, regulatory affairs, and ethics.

Same as MGMTMBA 293.

Restriction: Master's Program in Biotechnology Management students only.

MOL BIO 253L. Stem Cell Laboratory. 4 Units.
Designed to prepare M.S. Biotechnology program students for a career in stem cell research. Laboratory training utilizes tissue culture, mouse and human embryonic stem cells, and is enhanced with didactic material and discussion.

Prerequisite: MOL BIO 250L and MOL BIO 251L.

Restriction: Biotechnology graduate students only.

MOL BIO 255. Structure-Function Relationships of Integral Membrane Proteins. 4 Units.
Integral membrane proteins such as voltage and ligand-gated ion channels, water channels, pumps, cotransporters, and receptors (e.g., GPCRs). The emphasis is on the relationship between atomic structure and the functional properties of these proteins.

Prerequisite: BIO SCI 98 and BIO SCI 99. BIO SCI 98 with a grade of B or better. BIO SCI 99 with a grade of B or better.

Concurrent with BIO SCI M160.

MOL BIO 270. Science Communication Skills. 2 Units.
Development of effective communication skills, oral and written presentations. Topics range from the art of creating keynote slides to strategically crafting a personal story, culminating in a live presentation to an invited audience.

MOL BIO 280. Advanced Topics in Biochemistry and Molecular Biology. 3 Units.
Selected topics in specified areas of concentration, e.g., nucleic acids, protein biochemistry, genetic expression, biochemical genetics. Specific topics announced in advance.

Restriction: Graduate students only.
MOL BIO 291. Graduate School Fundamentals. 2 Units.
Lectures and discussions providing basic skills needed for success in Ph.D. graduate studies. Topics include formulating a hypothesis, experimental
design, literature review, grant writing, oral communication, biostatistics, time management, and professional development.

Grading Option: Satisfactory/unsatisfactory only.

Restriction: First-year students in the Cellular and Molecular Biosciences gateway Ph.D. program.

MOL BIO 292A. Scientific Communication. 2 Units.
Small group meetings for graduate students to practice scientific writing, debate, and presentation skills.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

MOL BIO 292B. Scientific Communication. 2 Units.
Small group meetings for graduate students to practice scientific writing, debate, and presentation skills.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

MOL BIO 292C. Scientific Communication. 2 Units.
Small group meetings for graduate students to practice scientific writing, debate, and presentation skills.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

MOL BIO 293A. Cancer Biology Journal Club. 1 Unit.
Focuses on molecular mechanisms that underlie the development and progression of cancers. Covers a variety of cancer-related research areas, such
as cell cycle control, apoptosis, DNA repair, metastasis, angiogenesis, and others.

Grading Option: Satisfactory/unsatisfactory only.

Restriction: Graduate students only.

MOL BIO 293B. Cancer Biology Journal Club. 1 Unit.
Focuses on molecular mechanisms that underlie the development and progression of cancers. Covers a variety of cancer-related research areas, such
as cell cycle control, apoptosis, DNA repair, metastasis, angiogenesis, and others.

Grading Option: Satisfactory/unsatisfactory only.

Restriction: Graduate students only.

MOL BIO 293C. Cancer Biology Journal Club. 1 Unit.
Focuses on molecular mechanisms that underlie the development and progression of cancers. Covers a variety of cancer-related research areas, such
as cell cycle control, apoptosis, DNA repair, metastasis, angiogenesis, and others.

Grading Option: Satisfactory/unsatisfactory only.

Restriction: Graduate students only.

MOL BIO 295. Biomedical Research Methods. 2 Units.
Lectures and interactive discussions of research methods in modern biomedical science. Each week will focus on a different class of techniques,
including molecular, biochemical, immunological, genomic, bioinformatics, microscopy, cancer biology, genome editing. One hour per week, grading
based on attendance.

Grading Option: Satisfactory/unsatisfactory only.

Restriction: Enrollment restricted to 1st year students in the Cellular & Molecular Biosciences gateway Ph.D. program. Other Ph.D. candidates may audit.

MOL BIO 399. University Teaching. 4 Units.
Limited to Teaching Assistants.

Restriction: Graduate students only.
Neurobiology and Behavior Courses

NEURBIO 200A. Research in Neurobiology and Behavior. 2-12 Units.
Individual research with Neurobiology and Behavior faculty.

Repeatability: Unlimited as topics vary.
Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 200B. Research in Neurobiology and Behavior. 2-12 Units.
Individual research with Neurobiology and Behavior faculty.

Prerequisite: NEURBIO 200A.
Repeatability: Unlimited as topics vary.
Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 200C. Research in Neurobiology and Behavior. 2-12 Units.
Individual research with Neurobiology and Behavior faculty.

Prerequisite: NEURBIO 200B.
Repeatability: Unlimited as topics vary.
Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 201A. Research in Neurobiology and Behavior. 2-12 Units.
Individual research with Neurobiology and Behavior faculty.

Grading Option: Satisfactory/unsatisfactory only.
Repeatability: Unlimited as topics vary.
Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 201B. Research in Neurobiology and Behavior. 2-12 Units.
Individual research with Neurobiology and Behavior faculty.

Prerequisite: NEURBIO 201A.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: Unlimited as topics vary.
Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 201C. Research in Neurobiology and Behavior. 2-12 Units.
Individual research with Neurobiology and Behavior faculty.

Prerequisite: NEURBIO 201B.
Grading Option: Satisfactory/unsatisfactory only.
Repeatability: Unlimited as topics vary.
Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 202A. Foundations of Neuroscience. 2 Units.
Intended to expose students to critical reading and analysis of the primary neuroscience literature. Instructors from departments associated with the Interdepartmental Neuroscience Program participate and discuss topics of current interest.

Grading Option: Satisfactory/unsatisfactory only.
NEURBIO 202B. Foundations of Neuroscience. 2 Units.
Intended to expose students to critical reading and analysis of the primary neuroscience literature. Instructors from departments associated with the Interdepartmental Neuroscience Program participate and discuss topics of current interest.

Prerequisite: NEURBIO 202A.

Grading Option: Satisfactory/unsatisfactory only.

NEURBIO 202C. Foundations of Neuroscience. 2 Units.
Intended to expose students to critical reading and analysis of the primary neuroscience literature. Instructors from departments associated with the Interdepartmental Neuroscience Program participate and discuss topics of current interest.

Prerequisite: NEURBIO 202B.

Grading Option: Satisfactory/unsatisfactory only.

NEURBIO 206. Molecular Neuroscience. 5 Units.
Surveys molecular and cellular mechanisms involved in neuronal function, including control of gene expression, post-transcriptional and post-translational processing, RNA and protein targeting, cell death mechanisms, and molecular genetic basis of neurological disorders. Overview of the molecular aspects of developmental neurobiology.

Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 207. Cellular Neuroscience. 5 Units.
Neurophysiological and neurochemical mechanisms of electrical and chemical signaling in neurons. Topics include generation of resting- and action-potentials, voltage- and ligand-gated ion channels, second messenger systems, and synaptic transmission and integration.

Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 207L. Cellular Neuroscience Laboratory. 2 Units.
Intensive hands-on laboratory experience of contemporary techniques for studying ion channels and synaptic function. Experiments include microelectrode recording, patch clamp, quantal analysis of synaptic transmission, heterologous expression of genes for channels and receptors, brain slice, and fluorescence calcium imaging.

Grading Option: Satisfactory/unsatisfactory only.

Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 208A. Systems Neuroscience. 5 Units.
Study of the mammalian nervous system at the systems level. Anatomy and physiology of sensory, motor, and integrative functions.

Repeatability: May be taken for credit 2 times.

Same as ANATOMY 210A.

Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 208B. Systems Neuroscience. 5 Units.
Study of the mammalian nervous system at the systems level. Anatomy and physiology of sensory, motor, and integrative functions.

Prerequisite: NEURBIO 208A.

Repeatability: May be taken for credit 2 times.

Same as ANATOMY 210B.

Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 209. Behavioral Neuroscience. 5 Units.
Overview of fundamental conceptual and experimental issues in the neurobiology of learning and memory. The approach is a cross-level integration of research in molecular-genetic, cellular, circuit, systems, and behavioral analyses.

Restriction: Neurobiology and Behavior graduate students only.
NEURBIO 230. Chromatin Structure and Function. 4 Units.
Focuses on the role of chromatin/nuclear structure organization in eukaryotic genome regulation. The effects of histone and DNA modification, chromatin remodeling, higher order chromatin structure and nuclear organization on gene regulation, DNA replication, and repair are discussed.
Prerequisite: MOL BIO 203 or MOL BIO 204 or NEURBIO 206.
Same as BIOCHEM 225.
Restriction: Graduate students only.

NEURBIO 231. Clinical and Epidemiological Aspects of Neurodegenerative Diseases. 4 Units.
Clinical and epidemiological aspects of neurodegenerative disorders causing dementia will be reviewed, including AD, PD, FTD, HD and cerebrovascular disease. Seminar format will include student presentations and group discussion.
Restriction: Graduate students only.

NEURBIO 232. Regenerative Neurobiology. 4 Units.
Surveys the latest research on regenerative neurobiology. Both basic stem cell discoveries and their potential clinical application to brain disorders will be examined.

NEURBIO 234. Cognitive Neuroepigenetics. 4 Units.
Covers current topics in the emerging field of cognitive neuroepigenetics, focusing on understanding the underlying epigenetic mechanisms of memory formation and persistence. Primary literature will be used to explore these processes.
Repeatability: May be repeated for credit unlimited times.

NEURBIO 235. Balancing Research and Teaching. 1 Unit.
The goal of this course is to offer graduate students who have commitments outside of their research program (such as teaching) an opportunity to learn to balance these commitments.

NEURBIO 236. Cortex: Structure, Function, and Plasticity. 4 Units.
Structured to include lectures and presentation of papers about cortex with emphasis on sensory-motor cortex. Both historical and current perspectives on cortical structure-function relationship will be critically evaluated.

NEURBIO 237. Neurobiology of Brain Aging. 4 Units.
Outlines some of the significant changes that occur in the aging brain, with a special emphasis on risk factors and protective strategies that promote successful brain aging. Topics include changes in synaptic plasticity, neurotrophic factors, and molecular mechanisms in aging.
Prerequisite: NEURBIO 209.

NEURBIO 238. Neurobiology of Memory as a Multidisciplinary Science. 4 Units.
The study of memory is a highly multidisciplinary science ranging from molecular and cellular studies in reduced preparations to functional imaging studies in humans. The focus is to integrate across approaches and levels of analysis to better understand how the hippocampus, and its constituent elements, suberves memory. Emphasis on the challenges of this multidisciplinary field.
Restriction: Majors only

NEURBIO 239. Functional Imaging of the Nervous System. 4 Units.
Overview of technical and applied aspects of imaging techniques available for studying the nervous system. The areas emphasized are cellular and subcellular imaging of neural function, systems-level imaging of brain function, and imaging of the human brain.
Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 240. Advanced Analysis of Learning and Memory. 4 Units.
Advanced analysis of contemporary research concerning the nature and neurobiological bases of learning and memory. Special emphasis is given to time-dependent processes involved in memory storage.
Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 244. Cognitive Neuroscience of Human Memory. 4 Units.
In-depth treatment of current topics of interest in the cognitive neuroscience of human long-term memory. Topics include methods of investigation of human memory, functional architecture of memory, implicit vs. explicit distinction, and control processes in memory, among others.
Prerequisite: NEURBIO 209.
NEURBIO 247. MATLAB for Neuroscientists. 4 Units.
A neuroscience-specific introduction to scientific programming and data analysis using MATLAB. Students will learn general programming skills and effective use of MATLAB for statistical analysis, image analysis, and GUI design to aid in neuroscience research.

NEURBIO 248. Topics in Neurobiology and Behavior. 4 Units.
Studies in selected areas of Neurobiology and Behavior. Topics addressed vary each quarter.

Repeatability: May be taken for credit 3 times.

NEURBIO 249. Electronics for Biologists. 4 Units.
Basic principles of electricity; properties and use of discrete components and integrated circuits; circuit analysis and design. Intended for advanced students in the life sciences.

Same as PHYSIO 205.

NEURBIO 250. Basal Ganglia and Movement Disorders. 4 Units.
Principles underlying the organization and functions of the basal ganglia and amygdala are considered. The circuitry, neurotransmitters, and influences on cortex and brainstem motor regions are discussed. Clinical disorders of the basal ganglia, including parkinsonism and ballism, are included.

Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 254. Molecular Neurobiology. 4 Units.
The application of genetic and recombinant DNA technology to neurobiology. Topics include the study of neuronal proteins which play important roles in the formation of synapses and synaptic transmission.

Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 255. History of Neuroscience. 4 Units.
An overview of the conceptual and technical foundations of contemporary neuroscience from ancient times to the present. The subjects include synapses, neurons, brain organization, sensory, motor and regulatory systems, learning and memory, human brain function and dysfunction.

Repeatability: May be taken for credit 2 times.

Restriction: Neurobiology and Behavior graduate students only.

Concurrent with BIO SCI N119.

NEURBIO 257. Statistics for Neurobiologists. 4 Units.
Introduction to common methods for statistical analysis used in neurobiology. Topics covered include t-tests, ANOVAs, correlations and regressions, general linear model, power analysis, and non-parametric tests.

Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 260. Auditory Neuroscience. 4 Units.
multidisciplinary overview of brain mechanisms of hearing. Emphasizes breath of auditory function and research: single neurons to psychoacoustics, the cochlea to the cortex, and basic science to clinic.

NEURBIO 261. Advanced Topics in Neurodegeneration. 4 Units.
Neurodegenerative disorders represent one of the most devastating illnesses to afflict humans, and usually occur in an age-dependent fashion. Course reviews the basic mechanisms that underlie cognitive and motor dysfunction in the major disorders of the brain.

Prerequisite: NEURBIO 206.

NEURBIO 265. Developmental Neurobiology—Wiring the Brain. 4 Units.
The development of the nervous system is discussed with particular emphasis on the processes that underlie the appearance of complex and highly ordered neural circuits. Topics include neuronal migration, axon guidance, and formation and maintenance of synaptic connections.

NEURBIO 290. Colloquium in Neurobiology and Behavior. 1.3 Unit.
Presentation of contemporary research problems in neurobiology and behavior and related areas by invited speakers.

Grading Option: Satisfactory/unsatisfactory only.

Repeatability: May be repeated for credit unlimited times.

Restriction: Neurobiology and Behavior graduate students only.
NEURBIO 292. Scientific Communication. 4 Units.
Students learn how to effectively communicate scientific ideas and results. Activities include learning how to effectively write a scientific manuscript, how to perform a coherent slide presentation, and how to run-through a poster presentation.

Restriction: Neurobiology and Behavior graduate students only.

NEURBIO 399. University Teaching. 1-4 Units.
Limited to Teaching Assistants.

Repeatability: May be repeated for credit unlimited times.

Restriction: Graduate students only.