

# BIOLOGICAL SCIENCES

College of Natural Sciences and Mathematics

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**Administrative Support Coordinator:** vacant

**Advisors:**

**Credential:** James Kisiel, Tim Williamson

**Undergraduate:**

General Biology, Biology Education, Botany, Ecology, and Zoology – David G. Huckaby

Cell and Molecular Biology – Kay K. Lee-Fruman

Marine Biology – Gwen Goodmanlowe

Microbiology – L.K. (Vern) Eveland

Physiology – Balwant S. Khatra

**Graduate:** Christopher Lowe

**Honors in the Major Advisor:** vacant

**Health Professions Advising Office** (HSCI 164)

**Clinical Laboratory Scientist/Medical Technology Advisor**

**Biotechnology Certificate Advisor:** Lisa S. Klig

Students desiring information should contact the department office for referral to one of the faculty advisors.

## Career Possibilities

Biologist • Lab Technician • Biological Aide • Technical Writer • Biological Illustrator • Forester • Quality Control Technician • Biomedical Engineer • Pharmaceutical Sales Representative • Fish and Wildlife Biologist • Food Technologist • Microbiologist • Criminologist • Dietitian • Medical Technologist • Health Planner • Physician's Assistant • Medical Librarian • Respiratory Therapist • Curator • Ecologist • Environmental Specialist • Sanitarian (Some of these, and other careers, require additional education or experience. For more information, see [www.careers.csulb.edu](http://www.careers.csulb.edu).) Various entry-level trainee positions in business and industry are available for graduates regardless of academic discipline.

## Introduction

The biological sciences include all of the areas of scientific endeavor centered around the general question of the nature of life. Such diverse areas as biochemistry, ecology, paleontology, and animal behavior are all part of the biological sciences. The discipline of biochemistry is located in the department of Chemistry and Biochemistry and the discipline of paleontology is located in the department of Geological Sciences. For information about

the programs in these disciplines, consult the appropriate section of this catalog. The remaining disciplines of the biological sciences represented in the College of Natural Sciences and Mathematics are located in the Department of Biological Sciences, which offers five degrees: a Bachelor of Science in Biology, a Bachelor of Science in Marine Biology, a Bachelor of Science in Microbiology, a Master of Science in Biology, and a Master of Science in Microbiology. The B.S. in Biology has, in addition to a general option, six specialized options in Biology Education, Botany, Cell and Molecular Biology, Ecology, Physiology, and Zoology. See below for the specific requirements for each of these degrees and options. The Department of Biological Sciences also participates in the Desert Studies Consortium and the Ocean Studies Institute. Information on the latter program is listed in this catalog under Ocean Studies Institute.

## Academic Advising and Facilitated Enrollment into Classes

All entering students who declare a major in a degree program offered by this department need to contact the College of Natural Sciences and Mathematics' Academic Advising Center (HSCI 164) and participate in the College's Science Safari to Success (for first time freshmen) or EONS (Enrollment and Orientation in the Natural Sciences and Mathematics for transfer students) Program. These programs are held in July for those starting in the Fall Semester and in January for those starting in the Spring Semester. Department advisors will be available to provide an overview of the students' chosen baccalaureate degree program, to assist with academic advisement, to provide information on the many career opportunities available, and to aid students in enrolling in classes. Contact the CNSM Academic Advising Center (HSCI 164), Jensen Student Access to Sciences and Mathematics Center (HSCI 164), or department office for additional information.

## The Richard B. Loomis Research Award

This annual departmental award provides supply and travel support for thesis research projects. Graduate students submit research proposals to the department's Graduate Studies Committee, which grants funding to the more meritorious proposals.

## Handloser Graduate Student Tuition Grant

The Handloser Graduate Student Tuition Grant is offered to an outstanding M.S. Biology applicant interested in pursuing master's thesis research in the area of marine biology.

## Frank Schatzlein Scholarship Award

The Frank Schatzlein Scholarship Award is available to an outstanding undergraduate student in biological sciences, with upper division standing, studying in the area of cellular physiology. Applications can be obtained from the Biological Sciences Department Office during the month of March.

## Linda Warren Graham Medical Technology Scholarship

The Linda Warren Graham Medical Technology Scholarship is available to senior microbiology majors who have been applied/accepted into a Clinical Laboratory Scientist (or a Medical Technology) Internship program. Scholarship applications can be obtained from the Biological Sciences Department Office during the month of November prior to graduation.

## Target Speciality Products Scholarship

The Target Specialty Products Scholarship is designed to reward a hardworking, well-rounded undergraduate majoring in natural sciences or mathematics, with sophomore, junior or senior class standing. Students applying for this scholarship should be involved in school and community activities, be working either full or part-time, and must be interested in exploring future careers that combine science and business. Application forms and information are available in the Department of Biological Sciences office beginning the month of February.

## Financial Support, Assistantships

The Department of Biological Sciences offers to graduate students a limited number of teaching associate and graduate assistant appointments. Forms requesting consideration for these appointments are available in the department's Graduate Office. Duties consist of approximately 20 hours per week devoted to preparation and/or instruction in general undergraduate laboratory classes. These appointments are limited to a maximum of six semesters per individual.

The department also has a limited number of technical assistant positions as well as some hourly employment. Several members of the faculty have grants that provide for research assistantships. A number of scholarships are available through the university.

## Graduate and Health Professional Preparation

The department provides preparation for advanced study at the graduate level and for entry into various health professional schools. Students should consider the degree requirements listed in the catalog as minimal; some graduate schools, professional schools, or careers may require additional coursework in mathematics, physics, chemistry, or biological sciences.

Students desiring entrance into a graduate school to obtain a master's or doctoral degree in some area of the biological sciences should determine the entrance requirements for the school(s) of interest early in their undergraduate years. Specifically, students contemplating graduate work in mathematically oriented areas of the biological sciences should consider taking more calculus (MATH 122, 123, 224, and 364A or 370A will substitute for MATH 119A and 119B) and those contemplating graduate work in chemically oriented areas should consider taking additional chemistry (CHEM 251; 320A,B; 377A,B; 441A,B).

Students desiring entrance into one of the various health-related professional schools should consult with the Health Professions Advising Office in the College of Natural Sciences and Mathematics' Jensen Student Access to Science and Mathematics (SAS) Center (HSCI 164) for

more information. Most of these schools do not require students to major in any particular discipline but favor holders of a bachelor's degree; and want students who have done well in their major and who also took the prerequisite courses required by that particular school.

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## Undergraduate Programs

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### Bachelor of Science in Biology

This degree includes a general option in biology and three additional options for those desiring a more specialized program.

### Admission Under Impaction

Refer to the following website for additional impaction criteria: <http://www.csulb.edu/depts/enrollment/admissions/>.

### Biology (120 units)

This degree major is designed for students pursuing careers that involve the study of life; it is especially appropriate for those contemplating graduate work in the biological sciences. Students may not combine this option with any other in the B.S. in Biology nor with the B.S. in Marine Biology or Microbiology as part of a dual major. This option requires approximately 80-84 units in the major, of which 39-41 are in lower division and 41-43 are in upper division.

All students must achieve at least a 2.0 grade-point average in each of the following: 1. the entire college record, 2. all units attempted at CSULB, and 3. all courses in the major.

#### Lower Division:

Take all of the following courses:

BIOL 211 Introduction to Evolution and Diversity (4)  
Prerequisite/Corequisite: CHEM 111A with a grade of "C" or better.

BIOL 212 Intro to Cell and Molecular Biology (4)  
Prerequisites: BIOL 211, CHEM 111A with grades of "C" or better.  
Prerequisite/Corequisite: CHEM 111B.

BIOL 213 Intro to Ecology and Physiology (4)  
Prerequisites: BIOL 211, 212, CHEM 111B each with a grade of "C" or better.

BIOL 260 Biostatistics (3)  
Prerequisites: BIOL 211 or BIOL 207 or MICR 200; MATH 111 or 113 or 119A or 122 all with a grade of "C" or better.

CHEM 111A General Chemistry (5)  
Prerequisites: A passing score on the Chemistry Placement Examination and a "C" or better in MATH 113 or 117 or 119A or 122. One year of high school chemistry is strongly recommended.

CHEM 111B General Chemistry (5)  
Prerequisite: CHEM 111A with a grade of "C" or better.

NOTE: BIOL 111, 111L, 212, 212L, 213, 213L are required if courses were taken prior to catalog year 2010-11.

Take one course from the following:

MATH 119A Survey of Calculus I (3)  
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 113.

MATH 122 Calculus (4)  
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

Take one course from the following:

MATH 119B Survey of Calculus II (3)  
Prerequisite: MATH 119A or 122.

MATH 123 Calculus II (4)  
Prerequisite: A grade of "C" or better in MATH 122.

Take one of the following courses:

PHYS 100A General Physics (4)  
Prerequisite: MATH 109 or 113 or 117 or 119A or 120 or 122.

PHYS 151 Mechanics and Heat (4)  
Prerequisite/Corequisite: MATH 122.

Take one of the following courses:

PHYS 100B General Physics (4)  
Prerequisites: PHYS 100A.

PHYS 152 Electricity and Magnetism (4)  
Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.

The following courses do not meet any specific or elective requirements for this major: BIOL 100, 153, 153L, 200, 200L, 205, 205L, 207, 208; MICR 101 and 200.

Upper Division:

Take all of the following courses:

CHEM 322A Organic Chemistry (3)  
Prerequisite: CHEM 111B with a grade of "C" or better. Concurrent enrollment in CHEM 323A required except for students who have previously earned a "C" or better in CHEM 323A.

CHEM 322B Organic Chemistry (3)  
Prerequisites: CHEM 322A and CHEM 323A, both with a grade of "C" or better. Concurrent enrollment in CHEM 323B required except for students who have previously earned a "C" or better in CHEM 323B.

CHEM 323A Organic Chemistry Laboratory (1)  
Prerequisite: CHEM 111B with a grade of "C" or better. Concurrent enrollment in CHEM 322A required except for students who have previously earned a "C" or better in CHEM 322A.

CHEM 323B Organic Chemistry Laboratory (1)  
Prerequisites: CHEM 322A and CHEM 323A, both with a grade of "C" or better. Concurrent enrollment in CHEM 322B required except for students who have previously earned a "C" or better in CHEM 322B.

Take all of the following courses:

BIOL 312 Evolutionary Biology (3)  
Prerequisites: BIOL 211, 212, 213, 260 all with a grade of "C" or better.

BIOL 340 Molecular Cell Biology (3)  
Prerequisites: BIOL 211, 212; CHEM 320A or 322A or 327 all with a grade of "C" or better.

BIOL 350 General Ecology (3)  
Prerequisites: BIOL 211, 212, 213, 260; MATH 119A or 122 all with a grade of "C" or better. Chemistry and physics recommended.

BIOL 370 General Genetics (4)  
Prerequisites: BIOL 211, 212 and either BIOL 260 or CHEM 251 all with a grade of "C" or better.

BIOL 480 Seminars (1)  
Prerequisites: Consent of undergraduate [graduate] advisor. Undergraduates must have filed for graduation and be in their last semester. Classified post-baccalaureates must have been admitted to a second baccalaureate or a certificate.

Take at least one of the following courses/course pairs in physiology:

BIOL 342 Human/Mammalian Phys (3)  
Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better. Recommended: PHYS 100A,B.

BIOL 342L Lab in Human/Mammalian Phys (1)  
Prerequisite/Corequisite: BIOL 342 with a grade of "C" or better.

Or

BIOL 345 Comparative Animal Physio (3)  
Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better. and

BIOL 345L Lab in Comp Animal Phys (1)  
Prerequisite/Corequisite: BIOL 345 with a grade of "C" or better.

Or

BIOL 447 (3) Molecular Plant Physiology (3)  
Prerequisites: BIOL 340, 370, both with grade of "C" or better.

Take two of the following courses in animal and plant diversity. One of the courses must be BIOL 313, 316, 324, 427, or 439:

BIOL 313 Invertebrate Zoology (4)  
Prerequisites: BIOL 211, 212, 213 all with a grade of "C" or better.

BIOL 316 General Entomology (4)  
Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better.

BIOL 324 Vertebrate Zoology (4)  
Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better.

BIOL 419, Ichthyology (3)  
Prerequisites: BIOL 211, 212, 213, 260 and at least 6 additional units of upper division biological science, all with a grade of "C" or better. Recommended: BIOL 350, 353, and 370.

BIOL 421 Herpetology (3)  
Prerequisites: BIOL 260, 350, and one additional upper division biology course, all with a grade of "C" or better. Recommended: BIOL 312, 324, or 370.

BIOL 423 Mammalogy (3)  
Prerequisites: At least one of BIOL 312, 324, or 350, with a grade of "C" or better.

BIOL 424 Ornithology (3)  
Prerequisites: BIOL 211, 212, 213, 260 and three units of upper division BIOL, all with a grade of "C" or better. Recommended: BIOL 350.

BIOL 427 Vascular Plant Systematics (4)  
Prerequisite: BIOL 312 or 370 with a grade of "C" or better.

BIOL 439 Plant Morphology (4)  
Prerequisite: BIOL 312 or 370 with a grade of "C" or better.

Take three additional upper division courses in the Department of Biological Sciences totaling a minimum of nine units. At least six of these units must be at the 400 level.

Courses outside of BIOL that can also count toward these units include GEOG 481, CHEM 441A, and CHEM 448.

Courses that will not count towards these units are BIOL 301, 304, 305, 308, and MICR 300I.

Students contemplating graduate or professional school should consider taking 1-3 units of BIOL 496 in addition to the requirements listed above. With prior permission of the advisor for this option, students may use 3 units of BIOL 496 as an elective.

### Option in Biology Education (120 units)

This option is designed solely for students who wish to become secondary school Biology teachers. This option requires 82-92 units in the major, of which 50-52 are lower division and 32-40 are upper division. Prospective students should consult the Single Subject Science Education Advisor in the Department of Science Education early to plan their program.

All students must achieve at least a 2.0 grade-point average in each of the following: 1. the entire college record, 2. all units attempted at CSULB, and 3. all courses in the major.

Lower Division:

Take all of the following:

BIOL 153 Introduction to Marine Biology (3)

Prerequisites/Corequisites: Courses that fulfill the A.1 and B.2 GE requirements.

BIOL 211 Introduction to Evolution and Diversity (4)

Prerequisite/Corequisite: CHEM 111A with a grade of "C" or better.

BIOL 212 Intro to Cell and Molecular Biology (4)

Prerequisites: BIOL 211, CHEM 111A with grades of "C" or better.

Prerequisite/Corequisite: CHEM 111B.

BIOL 213 Intro to Ecology and Physiology (4)

Prerequisites: BIOL 211, 212, CHEM 111B with a grade of "C" or better.

BIOL 260 Biostatistics (3)

Prerequisites: BIOL 211 or BIOL 207 or MICR 200; MATH 111 or 113 or 119A or 122 all with a grade of "C" or better.

ASTR 100 Astronomy (3)

Corequisites: One course from General Education Category B.2 and ASTR 100L.

CHEM 111A General Chemistry (5)

Prerequisites: A passing score on the Chemistry Placement Examination and a "C" or better in MATH 113 or 117 or 119A or 122. One year of high school chemistry is strongly recommended.

CHEM 111B General Chemistry (5)

Prerequisite: CHEM 111A with a grade of "C" or better.

NOTE: BIOL 111, 111L, 212, 212L, 213, 213L are required if courses were taken prior to catalog year 2010-11.

Choose either:

GEOL 106 Earth Science for Teachers (4)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics, including algebra, geometry, and intermediate algebra or the equivalent.

or both of the following:

GEOL 102 General Geology (3)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent.

GEOL 104 Geology Laboratory (1)

Prerequisites/Corequisites: A course that fulfills the A.1 GE requirement and three years of high school mathematics including algebra, geometry, and intermediate algebra or the equivalent, and concurrent or prior enrollment in GEOL 102.

Take one of the following courses:

MATH 119A Survey of Calculus I (3)

Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 113.

MATH 122 Calculus I (4)

Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

Take one of the following courses:

MICR 200 General Microbiology for Health

Professionals (4)

Prerequisites: CHEM 111A or 140 with a grade of "C" or better and GE Foundation requirements.

MICR 211 General Microbiology (5)

Prerequisites: BIOL 211, 212; CHEM 111B, all with a grade of "C" or better.

Take one of the following courses:

PHYS 100A General Physics (4)

Prerequisite: MATH 109 or 113 or 117 or 119A or 120 or 122.

PHYS 151 Mechanics and Heat (4)

Prerequisite/Corequisite: MATH 122.

Take one of the following courses:

PHYS 100B General Physics (4)

Prerequisites: PHYS 100A.

PHYS 152 Electricity and Magnetism (4)

Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.

The following courses do not meet any specific or elective requirements for this major: BIOL 100, 200, 200L, 205, 205L, 207, 208; MICR 101.

Upper Division:

Take either:

CHEM 327 Organic Chemistry (3)

Prerequisite: CHEM 111A with a grade of "C" or better; CHEM 111B is recommended.

or all four of the following courses:

CHEM 322A Organic Chemistry (3)

Prerequisite: CHEM 111B with a grade of "C" or better. Concurrent enrollment in CHEM 323A required except for students who have previously earned a "C" or better in CHEM 323A.

CHEM 322B Organic Chemistry (3)

Prerequisites: CHEM 322A and CHEM 323A, both with a grade of "C" or better. Concurrent enrollment in CHEM 323B required except for students who have previously earned a "C" or better in CHEM 323B.

CHEM 323A Organic Chemistry Laboratory (1)

Prerequisite: CHEM 111B with a grade of "C" or better. Concurrent enrollment in CHEM 322A required except for students who have previously earned a "C" or better in CHEM 322A.

CHEM 323B Organic Chemistry Laboratory (1)

Prerequisites: CHEM 322A and CHEM 323A, both with a grade of "C" or better. Concurrent enrollment in CHEM 322B required except for students who have previously earned a "C" or better in CHEM 322B.

Take the following course:

SCED 404 The Nature of Science and Scientific

Reasoning for Teachers (3)

Prerequisites: At least three-fourths of the credential specialization courses for Single Subject Teaching Credential in science and consent of instructor. Enrollment limited to students who intend to pursue a Single Subject Credential in Science.

Take at least nine courses totaling at least 26-29 units in the biological sciences including:

All of the following courses:

BIOL 312 Evolutionary Biology (3)

Prerequisites: BIOL 211, 212, 213, 260 all with a grade of "C" or better.

BIOL 340 Molecular Cell Biology (3)

Prerequisites: BIOL 211, 212; CHEM 320A or 322A or 327 all with a grade of "C" or better.

BIOL 350 General Ecology (3)

Prerequisites: BIOL 211, 212, 213, 260; MATH 119A or 122 all with a grade of "C" or better. Chemistry and physics recommended.

BIOL 370 General Genetics (4)

Prerequisites: BIOL 211, 212 and either BIOL 260 or CHEM 251 all with a grade of "C" or better.

BIOL 480 Seminars (1)

Prerequisites: Consent of undergraduate [graduate] advisor. Undergraduates must have filed for graduation and be in their last semester. Classified post-baccalaureates must have been admitted to a second baccalaureate or a certificate.

One of the following courses in physiology:

BIOL 345 Comparative Animal Physiology (3)  
Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better.

BIOL 447 Molecular Plant Physiology (3)  
Prerequisites: BIOL 340, 370, both with grade of "C" or better.

One of the following courses in plant diversity:

BIOL 427 Vascular Plant Systematics (4)  
Prerequisite: BIOL 312 or 370 with a grade of "C" or better.

BIOL 439 Plant Morphology (4)  
Prerequisite: BIOL 312 or 370 with a grade of "C" or better.

One of the following courses in animal diversity:

BIOL 313 Invertebrate Zoology (4)  
Prerequisites: BIOL 211, 212, 213 all with a grade of "C" or better.

BIOL 316 General Entomology (4)  
Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better.

BIOL 324 Vertebrate Zoology (4)  
Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better.

The remaining biological sciences course should be chosen in consultation with an advisor; BIOL 495/MICR 495 is highly recommended. Either CHEM 441A, B or 448 will count toward this additional required course. Students may use BIOL or MICR 496 as one of the nine required upper division courses but only with prior permission of the advisor for this option.

The following courses do not meet any specific or elective requirements for this major: BIOL 301, 304, 305, 308; MICR 300I; and NSCI 492.

Although SCED 403 and EDSS 300C are not required in the major, the credential does require these courses. Students may want to take some or all of them prior to graduation.

### Single Subject Teaching Credential in Biology

The Biological Sciences Concentration meets the subject matter competence requirement for the Single Subject Teaching Credential in Biology. In addition to meeting the subject matter competence requirement for the Teaching Credential, prospective Biology teachers are also required to complete 45 units of professional preparation in the Single Subject Credential Program, including student teaching. Students may begin the professional preparation courses as early as the junior year. With careful planning, it is possible to complete many of the credential program courses as an undergraduate. Courses may also be started as a post-baccalaureate student. Refer to the Single Subject Teacher Education section of this catalog or the Single Subject Credential Program website ([www.ced.csulb.edu/single-subject](http://www.ced.csulb.edu/single-subject)) for a description of the professional preparation requirements, courses, and application procedures.

The Biological Sciences Subject Matter Program is being revised to meet new state standards. When the revised program has been approved by the Commission on Teacher Credentialing, the new course requirements will be in effect and supersede current requirements.

### Option in Organismal Biology (120 units)

This option is designed primarily for those interested in careers that involve the biology of animals, plants and

the study of organisms in relation to their environment. It is particularly appropriate for those seeking employment in private industry or government service as well as those students contemplating graduate work in these fields. This option requires approximately 81-84 units in the major, of which 39-41 units are in lower division and 42-43 are in upper division.

All students must achieve at least a 2.0 grade-point average in each of the following: 1. the entire college record, 2. all units attempted at CSULB, and 3. all courses in the major.

Lower Division:

Take all of the following courses:

BIOL 211 Introduction to Evolution and Diversity (4)  
Prerequisite/Corequisite: CHEM 111A with a grade of "C" or better.

BIOL 212 Intro to Cell and Molecular Biology (4)  
Prerequisites: Completion of BIOL 211 and CHEM 111A with grades of "C" or better.  
Prerequisite/Corequisite: CHEM 111B with grade of "C" or better.

BIOL 213 Intro to Ecology and Physiology (4)  
Prerequisites: BIOL 211, 212, CHEM 111B all with a grade of "C" or better.

BIOL 260 Biostatistics (3)  
Prerequisites: BIOL 211 or BIOL 207 or MICR 200; MATH 111 or 113 or 119A or 122 all with a grade of "C" or better.

CHEM 111A General Chemistry (5)  
Prerequisites: A passing score on the Chemistry Placement Examination. (Credit in Chem 101 does not substitute for a passing score on the Chemistry Placement Examination) and a "C" or better in MATH 113 or 117 or 119A or 122. One year of high school chemistry is strongly recommended. (Recommended for students who intend to pursue careers in science or engineering).

CHEM 111B General Chemistry (5)  
Prerequisite: CHEM 111A with a grade of "C" or better.

NOTE: BIOL 111, 111L, 212, 212L, 213, 213L are required if courses were taken prior to catalog year 2010-11.

Take one of the following courses:

MATH 119A Survey of Calculus I (3)  
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 113.

MATH 122 Calculus I (4)  
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

Take one of the following courses:

MATH 119B Survey of Calculus II (3)  
Prerequisite: MATH 119A or 122.

MATH 123 Calculus II (4)  
Prerequisite: A grade of "C" or better in MATH 122.

Take one of the following courses:

PHYS 100A General Physics (4)  
Prerequisite: MATH 109 or 113 or 117 or 119A or 120 or 122.

PHYS 151 Mechanics and Heat (4)  
Prerequisite/Corequisite: MATH 122.

Take one of the following courses:

PHYS 100B General Physics (4)  
Prerequisites: PHYS 100A.

PHYS 152 Electricity and Magnetism (4)  
Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.

The following courses do not meet any specific or elective requirements for this major: BIOL 100, 153, 153L, 200, 200L, 205, 205L, 207, 208; MICR 101 and 200.

Upper Division:

Take a minimum of 42 upper division units to include the following:

Take one of the following course combinations in Organic Chemistry or Biochemistry (Groups A or B):

**Group A**

**CHEM 322A Organic Chemistry (3)**

Prerequisite: CHEM 111B with a grade of "C" or better. Concurrent enrollment in CHEM 323A required except for students who have previously earned a "C" or better in CHEM 323A.

**CHEM 322B Organic Chemistry (3)**

Prerequisites: CHEM 322A and CHEM 323A, both with a grade of "C" or better. Concurrent enrollment in CHEM 323B required except for students who have previously earned a "C" or better in CHEM 323B.

**CHEM 323A Organic Chemistry Laboratory (1)**

Prerequisite: CHEM 111B with a grade of "C" or better. Concurrent enrollment in CHEM 322A required except for students who have previously earned a "C" or better in CHEM 322A.

**CHEM 323B Organic Chemistry Laboratory (1)**

Prerequisites: CHEM 322A and CHEM 323A, both with a grade of "C" or better. Concurrent enrollment in CHEM 322B required except for students who have previously earned a "C" or better in CHEM 322B.

**Group B**

**CHEM 327 Organic Chemistry (3)**

Prerequisite: CHEM 111A with a grade of "C" or better; CHEM 111B is recommended.

**CHEM 448 Fundamentals of Biological Chemistry (3)**

Prerequisites: CHEM 327 or 322B either with a grade of "C" or better.

Few, if any, health-related professional schools (e.g. veterinary medicine) will accept CHEM 327. Some graduate programs with masters or doctorates in biology and/or ecology may also not accept CHEM 327. Students interested in these programs might consider taking CHEM 322A,B and 323A,B. CHEM 327 is not acceptable as a prerequisite for CHEM 441A. CHEM 327 is acceptable toward the Minor in Chemistry.

Take all of the following courses: (11 units)

**BIOL 312 Evolutionary Biology (3)**

Prerequisites: BIOL 211, 212, 213, 260 all with a grade of "C" or better.

**BIOL 350 General Ecology (3)**

Prerequisites: BIOL 211, 212, 213, 260; MATH 119A or 122 all with a grade of "C" or better. Chemistry and physics recommended.

**BIOL 370 General Genetics (4)**

Prerequisites: BIOL 211, 212 and either BIOL 260 or CHEM 251 all with a grade of "C" or better.

**BIOL 480 Seminars (1)**

Prerequisites: Consent of undergraduate [graduate] advisor. Undergraduates must have filed for graduation and be in their last semester. Classified post-baccalaureates must have been admitted to a second baccalaureate or a certificate.

Although BIOL 340 is not required for this option, it is a prerequisite for many 400-level courses and may be used as an elective.

Take at least one of the following courses/course pairs: 3-4 units

**BIOL 345 Comparative Animal Physiology (3)**

Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better, and

**BIOL 345L Lab in Comp Animal Physiology (1)**

Prerequisite/Corequisite: BIOL 345 with a grade of "C" or better.

Or

**BIOL 447 Molecular Plant Physiology (3)**

Prerequisites: BIOL 340, 370, both with grade of "C" or better.

Take at least two of the following courses in organismal diversity, one of which must be BIOL 313, 316, 324, 427, or 439:

**BIOL 313 Invertebrate Zoology (4)**

Prerequisites: BIOL 211, 212, 213 all with a grade of "C" or better.

**BIOL 316 General Entomology (4)**

Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better.

**BIOL 324 Vertebrate Zoology (4)**

Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better.

**BIOL 419, Ichthyology (3)**

Prerequisites: BIOL 211, 212, 213, 260 and at least 6 additional units of upper division biological science, all with a grade of "C" or better. Recommended: BIOL 350, 353, and 370.

**BIOL 421 Herpetology (3)**

Prerequisites: BIOL 260, 350, and one additional upper division biology course, all with a grade of "C" or better. Recommended: BIOL 312, 324, or 370.

**BIOL 423 Mammalogy (3)**

Prerequisite: At least one of BIOL 312, 324, or 350, with a grade of "C" or better.

**BIOL 424 Ornithology (3)**

Prerequisites: BIOL 211, 212, 213, 260 and three units of upper division BIOL, all with a grade of "C" or better. Recommended: BIOL 350.

**BIOL 427 Vascular Plant Systematics (4)**

Prerequisite: BIOL 312 or 370 with a grade of "C" or better.

**BIOL 439 Plant Morphology (4)**

Prerequisite: BIOL 312 or 370 with a grade of "C" or better.

Select a minimum of two courses from the following (any combination of courses from the two groups is acceptable):

**Ecology and Evolution Courses**

**BIOL/MICR 355 Microbial Ecology (3)**

Prerequisites: MICR 211 or BIOL 211, 212, 213 all with a grade of "C" or better.

**BIOL 412 Advanced Evolutionary Biology (3)**

Prerequisite: BIOL 312 with a grade of "C" or better.

**BIOL 450 Plant Ecology (3)**

Prerequisites: BIOL 260, 350 with a grade of "C" or better. Recommended: BIOL 427, 447.

**BIOL 451 Wetlands and Mangrove Ecology (3)**

Prerequisites: BIOL 260, 350 both with a grade of "C" or better.

**BIOL 452 Behavioral Ecology (3)**

Prerequisites: BIOL 211, 212, 213, 260 all with a grade of "C" or better. Prerequisite/Corequisite: BIOL 312 or 350.

**BIOL 453 Insect Ecology (3)**

Prerequisite: BIOL 350 with a grade of "C" or better.

**BIOL 454B Research in Tropical Terrestrial Ecology (3)**

Prerequisites: BIOL 350; one of BIOL 316, 324, 421, 424, 427, or 439 all with a grade of "C" or better; and consent of instructor.

**BIOL 456 Population Ecology (3)**

Prerequisites: BIOL 350, MATH 119B or 123 all with a grade of "C" or better.

**BIOL 457 Field Methods in Ecology (3)**

Prerequisites: BIOL 260, 350 both all with a grade of "C" or better.

**BIOL 459 Conservation Biology (3)**

Prerequisites: BIOL 260, 350 both with a grade of "C" or better. Recommended: BIOL 370.

BIOL 472 Molecular Evolution (3)  
Prerequisite: BIOL 370 with a grade of "C" or better.  
Recommended: BIOL 312.

#### *Physiology Courses*

BIOL 442 Physiology at the Limit (3)  
Prerequisites: BIOL 342 or 345 with a grade of "C" or better.

BIOL 443 Endocrinology (3)  
Prerequisites: BIOL 340 or CHEM 441B; CHEM 320A or 322A or 327; and one of BIOL 341, 342, 345, 445, 448; CHEM 441A or 448, all with a grade of "C" or better.

BIOL 444 Reproductive Biology (3)  
Prerequisite: BIOL 342 or 345 with a grade of "C" or better.

BIOL 449 Fish Physio and Endocrinology (3)  
Prerequisite: BIOL 345 with grade of "C" or better.

BIOL 464 Aquatic Toxicology (3)  
Prerequisites: BIOL 211, 212, 213, 340; CHEM 320A or 322A or 327, all with a grade of "C" or better. Recommended: BIOL 353 and CHEM 448 or 441A,B.

Take 2-3 additional upper division courses totaling 6-9 units in the Department of Biological Sciences so that a minimum number of 42 upper division units are completed. At least three of these units must be at the 400 level. Note that many 400 numbered courses require BIOL 340, which can also count as one of these elective courses.

Courses outside of BIOL that can also count toward these units include GEOG 481, CHEM 441A, and CHEM 448.

Courses that will not count towards these units are BIOL 301, 304, 305, 308, and MICR300I.

Students contemplating graduate or professional school should consider taking 1-3 units of BIOL 496 in addition to the requirements listed above. With prior permission of the advisor for this option, students may use 3 units of BIOL 496 as an elective.

### **Option in Molecular Cell Biology and Physiology (120 units)**

This option is designed primarily for those interested in careers that involve biology at the cell, molecular and organ system levels and is particularly appropriate for those contemplating graduate work in these fields or entering one of the health professions, such as medicine and physical therapy. Students in this option might also want to pursue the Certificate in Biotechnology described elsewhere in this Catalog. This option requires approximately 79-83 units in the major, of which 39-41 are in lower division and 40-42 are in upper division.

All students must achieve at least a 2.0 grade-point average in each of the following: 1. the entire college record, 2. all units attempted at CSULB, and 3. all courses in the major.

#### **Lower Division:**

Take all of the following courses:

BIOL 211 Introduction to Evolution and Diversity (4)  
Prerequisite/Corequisite: CHEM 111A with a grade of "C" or better.

BIOL 212 Intro to Cell and Molecular Biology (4)  
Prerequisites: Completion of BIOL 211 and CHEM 111A with grades of "C" or better.  
Prerequisite/Corequisite: CHEM 111B with grade of "C" or better.

BIOL 213 Intro to Ecology and Physiology (4)  
Prerequisites: BIOL 211, 212, CHEM 111B all with a grade of "C" or better.

BIOL 260 Biostatistics (3)  
Prerequisites: BIOL 211 or BIOL 207 or MICR 200; MATH 111 or 113 or 119A or 122 all with a grade of "C" or better.

CHEM 111A General Chemistry (5)  
Prerequisites: A passing score on the Chemistry Placement Examination. (Credit in Chem 101 does not substitute for a passing score on the Chemistry Placement Examination) and a "C" or better in MATH 113 or 117 or 119A or 122. One year of high school chemistry is strongly recommended. (Recommended for students who intend to pursue careers in science or engineering).

CHEM 111B General Chemistry (5)  
Prerequisite: CHEM 111A with a grade of "C" or better.

NOTE: BIOL 111, 111L, 212, 212L, 213, 213L are required if courses were taken prior to catalog year 2010-11.

Take one of the following courses:

MATH 119A Survey of Calculus I (3)  
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 113.

MATH 122 Calculus I (4)  
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

Take one of the following courses:

MATH 119B Survey of Calculus II (3)  
Prerequisite: MATH 119A or 122.

MATH 123 Calculus II (4)  
Prerequisite: A grade of "C" or better in MATH 122.

Take one of the following courses:

PHYS 100A General Physics (4)  
Prerequisite: MATH 109 or 113 or 117 or 119A or 120 or 122.

PHYS 151 Mechanics and Heat (4)  
Prerequisite/Corequisite: MATH 122.

Take one of the following courses:

PHYS 100B General Physics (4)  
Prerequisites: PHYS 100A.

PHYS 152 Electricity and Magnetism (4)  
Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.

Upper Division:

Take all of the following courses:

CHEM 322A Organic Chemistry (3)  
Prerequisite: CHEM 111B with a grade of "C" or better. Concurrent enrollment in CHEM 323A required except for students who have previously earned a "C" or better in CHEM 323A.

CHEM 322B Organic Chemistry (3)  
Prerequisites: CHEM 322A and CHEM 323A, both with a grade of "C" or better. Concurrent enrollment in CHEM 323B required except for students who have previously earned a "C" or better in CHEM 323B.

CHEM 323A Organic Chemistry Laboratory (1)  
Prerequisite: CHEM 111B with a grade of "C" or better. Concurrent enrollment in CHEM 322A required except for students who have previously earned a "C" or better in CHEM 322A.

CHEM 323B Organic Chemistry Laboratory (1)  
Prerequisites: CHEM 322A and CHEM 323A, both with a grade of "C" or better. Concurrent enrollment in CHEM 322B required except for students who have previously earned a "C" or better in CHEM 322B.

CHEM 441A Biological Chemistry (3)  
Prerequisite: Either CHEM 320B or both CHEM 322B and 323B with a grade of "C" or better; a biology or microbiology course is recommended.

CHEM 441B Biological Chemistry (3)  
Prerequisite: CHEM 441A with a grade of "C" or better.

Take all of the following courses:

- BIOL 340 Molecular Cell Biology (3)  
Prerequisites: BIOL 211, 212; CHEM 320A or 322A or 327 all with a grade of "C" or better.
- BIOL 370 General Genetics (4)  
Prerequisites: BIOL 211, 212 and either BIOL 260 or CHEM 251 all with a grade of "C" or better.
- BIOL 480 Seminars (1)  
Prerequisites: Consent of undergraduate [graduate] advisor. Undergraduates must have filed for graduation and be in their last semester. Classified post-baccalaureates must have been admitted to a second baccalaureate or a certificate.

Take one of the following:

- BIOL 312 Evolutionary Biology (3)  
Prerequisites: BIOL 211, 212, 213, 260 all with a grade of "C" or better.
- BIOL 350 General Ecology (3)  
Prerequisites: BIOL 211, 212, 213, 260; MATH 119A or 122 all with a grade of "C" or better. Chemistry and physics recommended.

Take at least one of the following courses/course pairs:

- BIOL 342 Human/Mammalian Phys (3)  
Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better. Recommended: PHYS 100A,B

And

- BIOL 342L Lab in Human/Mammalian Phys (1)  
Prerequisite/Corequisite: BIOL 342 with a grade of "C" or better.

Or

- BIOL 345 Comparative Animal Physio (3)  
Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better.

And

- BIOL 345L Lab in Comp Animal Phys (1)  
Prerequisite/Corequisite: BIOL 345 with a grade of "C" or better.

Or

- BIOL 440L Molecular Cell Biology Lab (3)  
Prerequisites: BIOL 340, 370, both with a grade of "C" or better, and consent of instructor.

If more than one is taken, the second course may count towards the electives below.

Take four courses totaling at least 12 units selected from the following:

- BIOL 431 Biology of Cancer (3)  
Prerequisites: BIOL 340, 370 with a grade of "C" or better.
- BIOL 432 Stem Cell Biology (3)  
Prerequisites: BIOL 433 with a grade of "C" or better.
- BIOL 433 Developmental Biology (3)  
Prerequisites: BIOL 340, and either BIOL 370 or MICR 371, both with a grade of "C" or better.
- BIOL 440L Molecular Cell Biology Lab (3)  
Prerequisites: BIOL 340, 370, both with a grade of "C" or better, and consent of instructor.
- BIOL 442 Physiology at the Limit (3)  
Prerequisites: BIOL 342 or 345 with a grade of "C" or better.
- BIOL 443 Endocrinology (3)  
Prerequisites: BIOL 340 or CHEM 441B; CHEM 320A or 322A or 327; and one of BIOL 341, 342, 345, 445, 448; CHEM 441A or 448, all with a grade of "C" or better.
- BIOL 444 Reproductive Biology (3)  
Prerequisite: BIOL 342 or 345 with a grade of "C" or better.
- BIOL 445 Metabolic Regulation (3)  
Prerequisites: BIOL 340, 342 or 345; CHEM 441A with grade of "C" or better.

- BIOL 447 Molecular Plant Physiology (3)  
Prerequisites: BIOL 340, 370, both with grade of "C" or better.

- BIOL 448 Principles of Neurobiology (3)  
Prerequisites: BIOL 340 or CHEM 441B and one of BIOL 341, 342, or 345 all with a grade of "C" or better.

- BIOL 449 Fish Physio and Endocrinology (3)  
Prerequisite: BIOL 345 with grade of "C" or better.

- BIOL 472 Molecular Evolution (3)  
Prerequisite: BIOL 370 with a grade of "C" or better.

- BIOL 473 Molecular Genetics (3)  
Prerequisites: BIOL 370 or MICR 371; CHEM 320A,B or 322A,B and 323A,B, or 327, all with a grade of "C" or better.

- BIOL 477 Biotechnology & Bioinformatics (4)  
Prerequisite: BIOL 340 or 370 or CHEM 441A,B; all with a grade of "C" or better.

- BIOL/MICR 416 Virology (3)  
Prerequisite: MICR 320 or BIOL 340 with a grade of "C" or better.

- BIOL/MICR 430 Immunology (3)  
Prerequisite: BIOL 340 with a grade of "C" or better.

With permission of the appropriate advisor, students may substitute one course in the biological sciences that is not on the above list for one of these four courses.

The following courses do not meet any specific or elective requirements for this major: BIOL 301, 304, 305, 308, 309I; MICR 300I; and NSCI 492.

Students contemplating graduate or professional school should consider taking 1-3 units of BIOL 496 in addition to the requirements listed above. With prior permission of the advisor for this option, students may use 3 units of BIOL 496 as an elective.

## Bachelor of Science in Marine Biology (120 units)

This degree program requires approximately 86-93 units in the major, of which 42-44 are in lower division and 44-49 are in upper division. The number of units and particular blend of science and mathematics makes this a very challenging learning experience. However, the depth and strength of this degree provides a strong and flexible base to pursue a variety of careers. Obtaining a minor in another discipline, such as chemistry, microbiology, engineering, business, or computer science, may enhance one's marketability. All students must achieve at least a 2.0 grade-point average in each of the following: 1. the entire college record, 2. all units attempted at CSULB, and 3. all courses in the major.

### Admission Under Impaction

Refer to the following website for additional impaction criteria: [http://www.csulb.edu/depts/enrollment/admissions/impacted\\_major.html](http://www.csulb.edu/depts/enrollment/admissions/impacted_major.html).

### Requirements

Lower Division:

Take all of the following courses:

- BIOL 153 Introduction to Marine Biology (3)  
Prerequisites/Corequisites: Courses that fulfill the A.1 and B.2 GE requirements.
- BIOL 211 Introduction to Evolution and Diversity (4)  
Prerequisite/Corequisite: CHEM 111A with a grade of "C" or better.
- BIOL 212 Intro to Cell and Molecular Biology (4)  
Prerequisites: BIOL 211, CHEM 111A with grades of "C" or better. Prerequisite/Corequisite: CHEM 111B.



BIOL 213 Intro to Ecology and Physiology (4)  
Prerequisites: BIOL 211, 212, CHEM 111B all with a grade of "C" or better.

BIOL 260 Biostatistics (3)  
Prerequisites: BIOL 211 or BIOL 207 or MICR 200; MATH 111 or 113 or 119A or 122 all with a grade of "C" or better.

CHEM 111A General Chemistry (5)  
Prerequisites: A passing score on the Chemistry Placement Examination and a "C" or better in MATH 113 or 117 or 119A or 122. One year of high school chemistry is strongly recommended.

CHEM 111B General Chemistry (5)  
Prerequisite: CHEM 111A with a grade of "C" or better.

NOTE: BIOL 111, 111L, 212, 212L, 213, 213L are required if courses were taken prior to catalog year 2010-11.

Take one of the following courses:

PHYS 100A General Physics (4)  
Prerequisite: MATH 109 or 113 or 117 or 119A or 120 or 122.

PHYS 151 Mechanics and Heat (4)  
Prerequisite/Corequisite: MATH 122.

Take one of the following courses:

PHYS 100B General Physics (4)  
Prerequisites: PHYS 100A.

PHYS 152 Electricity and Magnetism (4)  
Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.

Take one of the following courses:

MATH 119A Survey of Calculus I (3)  
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 113.

MATH 122 Calculus I (4)  
Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

Take one of the following courses:

MATH 119B Survey of Calculus II (3)  
Prerequisite: MATH 119A or 122.

MATH 123 Calculus II (4)  
Prerequisite: A grade of "C" or better in MATH 122.

The following courses do not meet any specific or elective requirements for this major: BIOL 100, 200, 200L, 205, 205L, 207, 208; MICR 101 and 200

Upper Division:

Take either:

CHEM 327 Organic Chemistry (3)  
Prerequisite: CHEM 111A with a grade of "C" or better; CHEM 111B is recommended.

or all four of the following courses:

CHEM 322A Organic Chemistry (3)  
Prerequisite: CHEM 111B with a grade of "C" or better. Concurrent enrollment in CHEM 323A required except for students who have previously earned a "C" or better in CHEM 323A.

CHEM 322B Organic Chemistry (3)  
Prerequisites: CHEM 322A and CHEM 323A, both with a grade of "C" or better. Concurrent enrollment in CHEM 323B required except for students who have previously earned a "C" or better in CHEM 323B.

CHEM 323A Organic Chemistry Laboratory (1)  
Prerequisite: CHEM 111B with a grade of "C" or better. Concurrent enrollment in CHEM 322A required except for students who have previously earned a "C" or better in CHEM 322A.

CHEM 323B Organic Chemistry Laboratory (1)  
Prerequisites: CHEM 322A and CHEM 323A, both with a grade of "C" or better. Concurrent enrollment in CHEM 322B required except for students who have previously earned a "C" or better in CHEM 322B.

Take all of the following courses:

BIOL 313 Invertebrate Zoology (4)  
Prerequisites: BIOL 211, 212, 213 all with a grade of "C" or better.

BIOL 340 Molecular Cell Biology (3)  
Prerequisites: BIOL 211, 212; CHEM 320A or 322A or 327 all with a grade of "C" or better.

BIOL 345 Comparative Animal Physiology (3)  
Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better.

BIOL 345L Lab in Comparative Animal Physiology (1)  
Prerequisite/Corequisite: BIOL 345 with a grade of "C" or better.

BIOL 350 General Ecology (3)  
Prerequisites: BIOL 211, 212, 213, 260; MATH 119A or 122 all with a grade of "C" or better. Chemistry and physics recommended.

BIOL 353 Marine Biology (3)  
Prerequisites: BIOL 153, 211, 212, 213, 260 all with grade of "C" or better.

BIOL 370 General Genetics (4)  
Prerequisites: BIOL 211, 212 and either BIOL 260 or CHEM 251 all with a grade of "C" or better.

BIOL 419 Ichthyology (3)  
Prerequisites: BIOL 211, 212, 213, 260 and at least 6 additional units of upper division biological science, all with a grade of "C" or better. Recommended: BIOL 350, 353, and 370.

BIOL 425 Phycology (4)  
Prerequisite: BIOL 353 with a grade of "C" or better.

BIOL 480 Seminars (1)  
Prerequisites: Consent of undergraduate [graduate] advisor. Undergraduates must have filed for graduation and be in their last semester. Classified post-baccalaureates must have been admitted to a second baccalaureate or a certificate.

GEOL 465 Physical and Chemical Oceanography (3)  
Prerequisites: CHEM 111B; PHYS 100B, and upper division standing in the College of Natural Sciences and Mathematics or Engineering.

GEOL 466 Oceanography Lab & Ocean Studies (1)  
Prerequisite/Corequisite: GEOL 465.

Take a minimum of three courses from the following: BIOL 411, 420, 449, 451, 454A, 455, 457, 464; BIOL/MICR 415; and, with prior permission of marine biology advisor for both BIOL 490, and 3 units of BIOL 496

The following courses do not meet any specific or elective requirements for this major: BIOL 301, 304, 305, 308; MICR 300I; and NSCI 492.

Few, if any, health-related professional schools (e.g. veterinary medicine) will accept CHEM 327. Some graduate programs with masters or doctorates in biology and/or marine biology may also not accept CHEM 327. Students interested in these programs might consider taking CHEM 322A,B and 323A,B. CHEM 327 is not acceptable as a prerequisite for CHEM 441A. CHEM 327 is acceptable toward the Minor in Chemistry.

## Bachelor of Science in Microbiology (120 units)

Microbiology is the study of microorganisms and their interactions with humans, other organisms, and the environment. This degree, with the inclusion of appropriate classes, may be utilized by pre-professional students who are preparing for medical, dental, pharmacy, and veterinary school. There is a core of courses and specific programs can be arranged by counseling with microbiology advisors. This undergraduate major is recognized by the American Society

for Microbiology as meeting their core curriculum for the baccalaureate degree program in microbiology. This major requires 83-84 units, of which 37-38 are in the lower division and 46 are in upper division. All students must achieve at least a 2.0 grade-point average in each of the following: 1. the entire college record, 2. all units attempted at CSULB, and 3. all courses in the major. **Admission Under**

### **Impaction**

Refer to the following website for additional impaction criteria: [http://www.csulb.edu/depts/enrollment/admissions/impacted\\_major.html](http://www.csulb.edu/depts/enrollment/admissions/impacted_major.html).

### **Requirements**

#### Lower Division:

Take all of the following courses:

##### CHEM 111A General Chemistry (5)

Prerequisites: A passing score on the Chemistry Placement Examination and a "C" or better in MATH 113 or 117 or 119A or 122. One year of high school chemistry is strongly recommended.

##### CHEM 111B General Chemistry (5)

Prerequisite: CHEM 111A with a grade of "C" or better.

##### BIOL 211 Introduction to Evolution and Diversity (4)

Prerequisite/Corequisite: CHEM 111A with a grade of "C" or better.

##### BIOL 212 Introduction to Cell and Molecular Biology (4)

Prerequisites: BIOL 211, CHEM 111A with grades of "C" or better.  
Prerequisite/Corequisite: CHEM 111B.

##### BIOL 260 Biostatistics (3)

Prerequisites: BIOL 211 or BIOL 207 or MICR 200; MATH 111 or 113 or 119A or 122 all with a grade of "C" or better.

##### MICR 211 General Microbiology (5)

Prerequisites: BIOL 211, 212; CHEM 111B, all with a grade of "C" or better.

NOTE: BIOL 111, 111L, 212, 212L, 213, 213L are required if courses were taken prior to catalog year 2010-11.

Take one of the following courses:

##### PHYS 100A General Physics (4)

Prerequisite: MATH 109 or 113 or 117 or 119A or 120 or 122.

##### PHYS 151 Mechanics and Heat (4)

Prerequisite/Corequisite: MATH 122.

Take one of the following courses:

##### PHYS 100B General Physics (4)

Prerequisites: PHYS 100A.

##### PHYS 152 Electricity and Magnetism (4)

Prerequisite: PHYS 151; Prerequisite/Corequisite: MATH 123.

Take one of the following courses:

##### MATH 119A Survey of Calculus I (3)

Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 113.

##### MATH 122 Calculus I (4)

Prerequisite: Appropriate MDPT placement or a grade of "C" or better in MATH 111 and 113, or a grade of "C" or better in MATH 117.

The following courses do not meet any specific or elective requirements for this major: BIOL 100, 153, 153L, 200, 200L, 205, 205L, 207, 208; MICR 101 and 200.

#### Upper Division:

Take all of the following courses:

##### CHEM 322A Organic Chemistry (3)

Prerequisite: CHEM 111B with a grade of "C" or better. Concurrent enrollment in CHEM 323A required except for students who have previously earned a "C" or better in CHEM 323A.

##### CHEM 322B Organic Chemistry (3)

Prerequisites: CHEM 322A and CHEM 323A, both with a grade of "C" or better. Concurrent enrollment in CHEM 323B required except for students who have previously earned a "C" or better in CHEM 323B.

##### CHEM 323A Organic Chemistry Laboratory (1)

Prerequisite: CHEM 111B with a grade of "C" or better. Concurrent enrollment in CHEM 322A required except for students who have previously earned a "C" or better in CHEM 322A.

##### CHEM 323B Organic Chemistry Laboratory (1)

Prerequisites: CHEM 322A and CHEM 323A, both with a grade of "C" or better. Concurrent enrollment in CHEM 322B required except for students who have previously earned a "C" or better in CHEM 322B.

##### CHEM 441A Biological Chemistry (3)

Prerequisite: Either CHEM 320B or both CHEM 322B and 323B with a grade of "C" or better; a biology or microbiology course is recommended.

##### CHEM 441B Biological Chemistry (3)

Prerequisite: CHEM 441A with a grade of "C" or better.

##### BIOL 340 Molecular Cell Biology (3)

Prerequisites: BIOL 211, 212; CHEM 320A or 322A or 327 all with a grade of "C" or better.

##### BIOL 480 Seminars (1)

Prerequisites: Consent of undergraduate [graduate] advisor. Undergraduates must have filed for graduation and be in their last semester. Classified post-baccalaureates must have been admitted to a second baccalaureate or a certificate.

##### MICR 320 Bacterial Pathogenesis (3)

Prerequisite: MICR 211 with a grade of "C" or better.

##### MICR 355 Microbial Ecology (3)

Prerequisites: MICR 211 or BIOL 211, 212, 213 all with a grade of "C" or better.

##### MICR 371 Microbial Genetics (3)

Prerequisite: MICR 211 with a grade of "C" or better.

##### MICR 372 Methods in Microbial Genetics (2)

Prerequisite: MICR 211 with a grade of "C" or better. Recommended: MICR 371.

##### MICR 430 Immunology (3)

Prerequisite: BIOL 340 with a grade of "C" or better.

##### MICR 471 Bacterial Physiology (3)

Prerequisites: MICR 320, CHEM 441A; both with a grade of "C" or better.

Take a minimum of 11 elective units chosen from the following:

BIOL 473, 477; MICR 320L, 322, 325, 355L, 416, 423, 429, 430L, 473, 490, and 495. Students may use MICR 496 towards the additional units but only with prior permission of the advisor for this degree. Those students seeking a career as a Clinical Laboratory Scientist/Medical Technologist are encouraged to take MICR 320L, 416, 423 and 430L.

The following courses do not meet any specific or elective requirements for this major: BIOL 301, 304, 305, 308; MICR 300I; and NSCI 492.

### **Bachelor of Science Degree with Honors in Biology, Marine Biology, or Microbiology**

Students majoring in the B. S. in Biology (all options), B. S. in Marine Biology, or B. S. in Microbiology who would like an enriched academic program, including an intensive research experience, may be eligible to graduate with Honors in the Major through the University Honors Program. Students may also complete General Honors through the

University Honors Program, in which case the General Honors thesis requirement is met through Honors in the Major (see University Honors in this catalog).

Students interested in graduating with Honors in the Major should participate in a series of courses designed to introduce central concepts in biology, develop critical thinking and communication skills (special section of UHP 100), and introduce the newly emerging field of bioinformatics. In addition, they may join a learning community of students with similar interests and benefit from mentoring by faculty members.

This Honors in the Major program was created with the support of a grant from the Howard Hughes Medical Institute. Students admitted to Honors in the Major may be eligible to receive monetary support from a variety of sources for completion of their honors research and thesis.

Students who have successfully completed the lower division Honors in the Major curriculum will receive priority for research fellowship support to the extent that it is available.

Additional details about this program, including availability of fellowship support, are available from the Honors in the Major Program Advisor.

### Requirements for Admission

1. Junior or senior standing with at least one year remaining before graduation.
2. Declared major of B. S. in Biology (any option), B. S. in Marine Biology, or B. S. in Microbiology.
3. Complete BIOL 211, 212, and 213 (BIOL 111, 111L, 212, 212L, 213, 213L are required if courses were taken prior to catalog year 2010-11) (or BIOL 211A,B), 260; CHEM 322A,B and 323A,B (or CHEM 320A,B) at time of entry with grades of at least a "C" in each course. Students may apply during the semester in which they expect to complete these courses.
4. GPAs of at least 3.000 in all courses in the major and in all upper division courses in the major at the time of application.
5. Submission of an application describing the student's academic background, reasons for applying (including a description of any previous research experience), and willingness to commit to a year-long research experience.
6. Letter of recommendation from a CSULB faculty member familiar with the student's work and abilities.

### Requirements for Graduation

1. GPA of at least 3.300 in all upper division courses in the major and in Honors courses.
2. Complete all requirements for the chosen degree in the Biological Sciences.
3. Complete BIOL 466 Research Design and Methods (3)
4. Complete BIOL 496 Undergraduate Directed Research (3)
5. Completion of BIOL 498H Thesis - Honors (3)
6. Presentation of research results in a public forum. This requirement may be met by presentation at a scientific conference or at a local venue; consult the Program Director for additional information

Substitutions to this program must be approved by the Honors in the Major Program Advisor.

## Minor in Biology

This minor may be combined with any major at CSULB except the B.S. in Biology (all options), B.S. in Microbiology, and B.S. in Marine Biology.

A minimum of 21 units is required for this minor.

Lower Division:

Take all of the following courses:

BIOL 211 Introduction to Evolution and Diversity (4)  
Prerequisite/Corequisite: CHEM 111A with a grade of "C" or better.

BIOL 212 Intro to Cell and Molecular Biology (4)  
Prerequisites: BIOL 211, CHEM 111A with grades of "C" or better.  
Prerequisite/Corequisite: CHEM 111B.

BIOL 213 Intro to Ecology and Physiology (4)  
Prerequisites: BIOL 211, 212, CHEM 111B all with a grade of "C" or better.

CHEM 111A and 111B are required if the courses are taken at CSULB.

NOTE: BIOL 111, 111L, 212, 212L, 213, 213L are required if courses were taken prior to catalog year 2010-11.

The following courses do not meet any specific or elective requirements for this minor: BIOL 100, 153, 153L, 200, 200L, 205, 205L, 207, 208; MICR 101 and 200.

Upper Division:

Take a minimum of nine units selected from upper division biology courses with at least one course selected from the 400 series. The nine units must include at least one course chosen from BIOL 312, 340, 350, and 370. Many of the upper division courses in biology also require either BIOL 260 or organic chemistry.

The following courses do not meet any specific or elective requirements for this minor: BIOL 301, 304, 305, 308, MICR 300I, 429, and NSCI 492.

## Minor in Physiology

This minor may be combined with any major at CSULB except the B.S. in Biology, Option in Physiology.

A minimum of 18 upper division units.

Twelve units must be selected from the following:  
BIOL 341, 342, 342L, 345, 345L, 443, 445, 448, 490.

Six units must be selected from other courses in the above list or from the following:

BIOL 473; CHEM 441A,B, 443, or 448.

At least one of the upper division courses taken for this minor must have a laboratory. Most of these upper-division courses require CHEM 111A,B and BIOL 211, 212, 213 as prerequisites; some have other prerequisites in addition.

The following courses do not meet any specific or elective requirements for this minor: BIOL 100, 153, 153L, 200, 200L, 205, 205L, 207, 208; MICR 101 and 200.

The following courses do not meet any specific or elective requirements for this minor: BIOL 301, 304, 305, 308, 309I; MICR 300I; and NSCI 492.

## Minor in Microbiology

This minor may be combined with any major at CSULB except the B.S. in Microbiology.

A minimum of 19 units which must include:

Lower Division:

MICR 211 General Microbiology (5)  
Prerequisites: BIOL 211, 212; CHEM 111B, all with a grade of "C" or better.

Upper Division:

Take all of the following courses:

MICR 320 Bacterial Pathogenesis (3)

Prerequisite: MICR 211 with a grade of "C" or better.

MICR 416 Virology (3)

Prerequisite: MICR 320 or BIOL 340 with a grade of "C" or better.

MICR 430 Immunology (3)

Prerequisite: BIOL 340 with a grade of "C" or better.

Take a minimum of five units from the following:

MICR 322, 371, 471, 473

The following courses do not meet any specific or elective requirements for this minor: BIOL 100, 153, 153L, 200, 200L, 205, 205L, 207, 208; MICR 101 and 200.

The following courses do not meet any specific or elective requirements for this major: BIOL 301, 304, 305, 308, MICR 300I, and NSCI 492

## Certificate Program in Biomedical Art

This is an interdisciplinary program sponsored by the Art and Biological Sciences departments. For requirements, see the Art section of this catalog.

## Certificate in Biotechnology

Biotechnology refers to a process which ultimately yields a product that can be loosely subdivided into five categories; biological organisms with novel traits, DNAs, RNAs, proteins, and compounds. The certificate may be earned in conjunction with or subsequent to a baccalaureate degree. Courses offered for the certificate may be used to satisfy, as appropriate, major or minor requirements.

This certificate program is eligible for Financial Aid. Please see the department web site for required Federal disclosure information.

### Prerequisites for Admission

Completion of the following courses with a grade of "C" or better (or consent of the biotechnology certificate program director): CHEM 111A,B; CHEM 320A,B or CHEM 322A,B and 323A,B; CHEM 441A,B; BIOL 340; BIOL 370; MICR 211.

The following courses do not meet any specific or elective requirements for this certificate: BIOL 100, 153, 153L, 200, 200L, 205, 205L, 207, 208; MICR 101 and 200.

### Requirements

1. A baccalaureate degree (can be concurrent);
2. Completion of prerequisites;
3. Approval by the program director;
4. Completion of the core curriculum:

BIOL 473/573 Molecular Genetics (3)

Prerequisites: BIOL 370 or MICR 371; CHEM 320A,B or 322A,B and 323A,B, or 327, all with a grade of "C" or better. (Undergraduates enroll in BIOL 473; graduates enroll in BIOL 573.)

BIOL 477/577 Biotechnology: Applications of Molecular Techniques and Bioinformatics (4)

Prerequisite: BIOL 340 or 370 or CHEM 441A,B; all with a grade of "C" or better. (Undergraduates enroll in BIOL 477; graduates enroll in BIOL 577.)

BIOL 480/580 Seminars (1)

Prerequisites: Consent of undergraduate [graduate] advisor. (Undergraduates and classified post-baccalaureates enroll in BIOL 480; graduates enroll in

BIOL 580). Undergraduates must have filed for graduation and be in their last semester. Graduates must have been admitted to the department as a graduate student. Classified post-baccalaureates must have been admitted to a second baccalaureate or a certificate.

NSCI 492 Internships In Natural Science (3)

Prerequisites: Major in the College of Natural Sciences and Mathematics, completion of 9 units of upper division science coursework, a 2.5 GPA overall or 2.75 GPA in the student's major, and consent of instructor prior to registration.

Take an additional 3 units selected in consultation with program director;

5. Completion of 3 units consisting of an approved research project in biotechnology to be taken from one or more of the following:

BIOL 496; CHEM 496; or MICR 496 (undergraduate students); BIOL 697; CHEM 697; or MICR 697 (graduate students);

6. BIOL 301, 304, 308 and MICR 300I do not meet any specific or elective requirements for this certificate.
7. Total 18 units required .

## Concurrent and/or Summer Enrollment in Another College

Students who wish to take coursework in a community or another college to meet curricular requirements while enrolled as undergraduates in the College of Natural Sciences and Mathematics must petition the appropriate department for prior approval to enroll in specific courses. This policy applies to concurrent enrollment or summer enrollment. University policy must also be met; see 'Concurrent Enrollment' and 'Transfer of Undergraduate Credit' in this catalog. Courses not receiving prior approval will not be accepted for credit by the department.

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## GRADUATE PROGRAMS

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### Master of Science in Biology

This degree requires a thesis based on original scientific research; a list of research areas with the names of faculty specializing in these areas can be obtained from the department's graduate office.

### Admission to the Department

#### Prerequisites

In addition to the prerequisites for entrance into CSULB as a graduate student, stated previously in this catalog under Graduate Degrees and Post Baccalaureate Studies, the Department of Biological Sciences requires:

1. The student is to find a faculty member in the department who agrees to serve as the thesis advisor of the student prior to her/his acceptance into the M.S. program;
2. A bachelor's degree in the biological or related sciences from an accredited institution. Students with alternative undergraduate degrees will be considered, but they will likely be assigned deficiency courses by the Thesis Advisor in consultation with the Graduate Advisor;
3. An undergraduate GPA in all completed science and mathematics courses of at least 2.70 OR a GPA of at least 3.00 in the last 40 semester (or 60 quarter) units of science and mathematics courses completed;

4. The GRE General Test (and, if required, the GRE Subject Test in Biology or in Biochemistry, Cell and Molecular Biology) must have been taken prior to applying to the Department. Scores are utilized as indicators for accrued knowledge and potential success in the M.S. program in Biology. The GREs must have been taken within five years prior to the intended admission date. Applicants without a degree in biological sciences must take the GRE Biology or Biochemistry, Cell and Molecular Biology Subject Test.

Students who do not meet the minimum required criteria for acceptance are encouraged to take post-baccalaureate courses to bring up their GPA or GRE scores.

### **Application**

Prospective graduate students in M.S. in Biology, including CSULB graduates, must formally apply for admission to CSULB as described previously in this catalog and must also apply directly to the Department of Biological Sciences. All applicants must submit the following documents directly to the Department no later than 1 February for the fall semester to receive consideration for admission:

1. Departmental Application Form, also available from the Department's Graduate Office;
2. A one page essay describing why the applicant wishes to obtain an M.S. degree in Biology at CSULB and how this relates to her/his career objectives;
3. Unofficial transcripts of all college level academic work, including those completed at CSULB (these are in addition to those transcripts required for general graduate admission to CSULB);
4. Three letters of recommendation from persons familiar with the applicant's academic performance and research potential (if also applying for a Teaching Associate position, the letters must refer to the applicant's potential to teach laboratory sections in the biological sciences); and
5. Official report of the GRE General Test scores. The applicant should have taken this examination prior to applying to the Department, because the official scores must reach the Department by the deadline above.

These materials must be submitted to the Graduate Office, Department of Biological Sciences, California State University, Long Beach, 1250 Bellflower Blvd., Long Beach, CA 90840-9502.

### **Review by the Graduate Studies Committee**

The Graduate Studies Committee will review all completed applications received by the deadlines. Admission into the M.S. Program in Biology is competitive, with an applicant's college GPA, GRE Test scores, one-page essay, and letters of recommendation weighed in the decision to accept or decline. Applicants who are admitted into the program will enter as either a Classified or Conditionally Classified Graduate Student, as described below. All admitted students must contact the Graduate Advisor prior to their first semester for counsel and orientation.

### **Admission to the Department of Biological Sciences as a Classified Graduate Student**

The Department of Biological Sciences may admit as a

Classified Graduate Student applicant who:

1. has met all prerequisites,
2. has a complete application folder, and
3. has obtained acceptance by a faculty member to serve as her/his Thesis Advisor.

### **Admission to the Department as a Conditionally Classified Graduate Student**

An applicant who fails to meet the above criteria for Classified Graduate Student may be considered by the Graduate Studies Committee for admission as Conditionally Classified Graduate Student:

An applicant with course deficiencies: The Graduate Advisor and student's Thesis Advisor will determine whether academic deficiencies exist for the particular field of study to be undertaken. The courses to be taken to make up deficiencies will be indicated on the back of the department application form. Such courses are in addition to the minimum 30 units on the student's Program of Study (see below). The applicant must make up all deficiencies before attaining Classified status.

### **The Thesis Proposal**

After admission to the Department as a Classified or Conditionally Classified graduate student, the student in consultation with the Thesis Advisor, must prepare her/his Thesis Proposal and Program of Study, which includes all coursework to be taken. The Thesis Proposal must include a thorough review of relevant primary literature that demonstrates the context of the proposed research, it must clearly define the experiments proposed for the research to be undertaken, and should include preliminary data, if available. The student and her/his Thesis Advisor will select at least two additional members to serve on the Thesis Committee. In most cases, the Thesis Advisor will serve as Chair of the Thesis Committee. However, if the Thesis Advisor is not eligible, another member of the Thesis Committee will serve as Thesis Committee Chair. The student will then have a formal meeting with the Thesis Committee, at which the student's Thesis Proposal and Program of Study will be presented and evaluated. At this meeting, the Thesis Committee will question the student about her/his Thesis Proposal. At the completion of this meeting, the Thesis Committee will meet briefly, without the student present, to evaluate the Thesis Proposal. Approval is based on whether the student has demonstrated a solid understanding of her/his thesis project. The Thesis Proposal must be prepared, presented to, and approved by the Thesis Committee before the end of the second semester after admission to the Department. Failure to meet this requirement will result in dismissal from the M.S. in Biology program.

### **The Program of Study**

The Program of Study must include six units of Thesis (BIOL 698), one to three units of Directed Research (BIOL 697), two units of Experimental Design (BIOL 696A), two units of Scientific Communication (BIOL 696B), one unit of Seminar (BIOL 580), and four units from: BIOL 663, 664, 665, 666; MICR 661; OR CHEM 595A; BIOL 663-666 and MICR 661 topics must be different. Of the minimum 30 units, no more than six may come from BIOL 663-666

and no more than two units of CHEM 595A; no more than six may come from transfer credit; and no more than one 300-level course may be included. Any 300-level course on a graduate program of study must be approved by the Thesis Advisor and the Graduate Advisor. BIOL 696A will be taken during the student's initial fall semester; the course will cover experimental design, statistics, and literature research, and help students in preparing their Thesis Proposal. BIOL 696B will be taken during the first spring semester in the program, and will cover both oral and written scientific presentation. BIOL 696B is intended to facilitate manuscript and thesis writing and to help students learn to articulate their findings for their thesis defense. The Program of Study must be prepared, presented to, and approved by the Thesis Committee before the end of the second semester after admission to the Department. Failure to meet this requirement will result in dismissal from the M.S. in Biology program.

### **Advancement to Candidacy**

In addition to the general University requirements stated previously under Post-Baccalaureate and Graduate Degrees in this catalog, the student must complete the following steps before receiving Master's Candidate status in the Department of Biological Sciences:

1. Admission to the Master's Degree program in Biology as a Classified graduate student (see above);
2. Acceptance of the Thesis Proposal and Program of Study by the Thesis Committee;
3. Satisfactory academic progress;
4. Satisfactory fulfillment of the Graduation Writing Assessment Requirement (GWAR).

The Thesis Committee will recommend the student for advancement to candidacy by forwarding its recommendation to the Department Graduate Advisor. This should occur at end of second semester after admission. Upon approval by the College's Associate Dean, the student will attain Master's Candidate status.

### **Requirements for the Master of Science in Biology**

The regulations governing the master's degree are those in effect at the time of advancement to candidacy. In addition to the general University requirements stated previously in this catalog, the student must meet the following requirements before receiving the degree of Master of Science in Biology. The requirements are:

1. Advancement to Master's Candidate status (see above);
2. Maintenance of a 3.00 ("B" average) or better, overall GPA (includes all upper-division and graduate level courses taken since admission to this University and after completion of the baccalaureate degree) and graduate program GPA. If either GPA falls below 3.00, it must be elevated to a 3.00 by the end of the following semester or the student will be dismissed from the M.S. program in Biology;
3. Successful completion of the following: written thesis and public defense followed by a private defense with the Thesis Committee; and
4. Service as a Teaching Associate or Graduate Assistant.

Requests to graduate must be received by Enrollment Services approximately 6 months in advance of the expected graduation date (Check the Schedule of Classes for the date).

These degree requirements must be completed within 6 years from when the first course on the Program of Study was completed, including academic leaves, or the student's degree program will be terminated.

## **Master of Science in Microbiology**

This degree is available to qualified students preparing for professional careers in industry and government and for further studies at the doctoral level. In addition, a master's degree in microbiology, combined with appropriate courses in education, can be utilized for a community college teaching credential.

### **Admission to the Department**

#### **Prerequisites**

In addition to the prerequisites for entrance into CSULB as a graduate student, stated previously in this catalog under Graduate Degrees and Post Baccalaureate Studies, the Department of Biological Sciences requires:

1. The student is required to find a faculty member in the department who agrees to serve as the thesis advisor of the student prior to her/his acceptance into the M.S. program;
2. A bachelor's degree in the biological or related sciences from an accredited institution. Students with alternative undergraduate degrees will be considered, but they will likely be assigned deficiency courses by the Thesis Advisor in consultation with the Graduate Advisor;
3. An undergraduate GPA in all completed science and mathematics courses of at least 2.70 OR a GPA of at least 3.00 in the last 40 semester (60 quarter) units of science and mathematics courses completed;
4. The GRE General Test (and, if required, the GRE Subject Test in Biology or in Biochemistry, Cell and Molecular Biology) must have been taken prior to applying to the Department. Scores are utilized as indicators for accrued knowledge and potential success in the M.S. program in Microbiology. The GREs must have been taken within five years prior to the intended admission date. Applicants without a degree in biological sciences must take the GRE Biology or Biochemistry, Cell and Molecular Biology Subject Test.

Students who do not meet the minimum required criteria for acceptance are encouraged to take post-baccalaureate courses to bring up their GPA or GRE scores.

#### **Application**

Prospective graduate students in M.S. in Microbiology, including CSULB graduates, must formally apply for admission to CSULB as described previously in this catalog and must also apply directly to the Department of Biological Sciences. All applicants must submit the following documents directly to the Department no later than 1 February for the fall semester to receive consideration for admission:

1. Departmental Application Form (PDF), also available from the Department's Graduate Office;
2. A one page essay describing why the applicant wishes to obtain an M.S. degree in Microbiology at CSULB and how this relates to her/his career objectives;
3. Unofficial transcripts of all college level academic work, including those completed at CSULB (these are in addition to those transcripts required for general graduate admission to CSULB);

4. Three letters of recommendation from persons familiar with the applicant's academic performance and research potential (if also applying for a Teaching Associate position, the letters must refer to the applicant's potential to teach laboratory sections in the biological sciences); and
5. Official report of the GRE General Test scores. The applicant should have taken this examination prior to applying to the Department, because the official scores must reach the Department by the deadline above.

These materials must be submitted to the Graduate Office, Department of Biological Sciences, California State University, Long Beach, 1250 Bellflower Blvd., Long Beach, CA 90840-9502.

### **Review by the Graduate Studies Committee**

The Graduate Studies Committee will review all completed applications received by the deadlines and either accept the applicant as a Classified or Conditionally Classified graduate student or deny admission. Acceptance is competitive and the GPA, the GRE Test scores, one-page essay, and the letters of recommendation will be weighed in the decision to accept or deny. All admitted applicants must contact the Graduate Advisor prior to their initial semester for counsel and orientation.

### **Admission to the Department of Biological Sciences as a Classified Graduate Student**

The Department of Biological Sciences may admit as a Classified Graduate Student any applicant who:

1. has met all prerequisites,
2. has a complete application folder, and
3. has obtained acceptance by a faculty member to serve as her/his Thesis Advisor.

### **Admission to the Department of Biological Sciences as a Conditionally Classified Graduate Student**

An applicant who fails to meet the above criteria for Classified Graduate Student admission may be considered by the Graduate Studies Committee for admission as Conditionally Classified graduate student:

An applicant with course deficiencies: The Graduate Advisor and student's Thesis Advisor will determine whether academic deficiencies exist for the particular field of study to be undertaken. The courses to be taken to make up deficiencies will be indicated on the back of the department application form. Such courses must be taken in addition to the minimum 30 units on the student's Program of Study (see below). The applicant must make up all deficiencies before attaining Classified status.

### **The Thesis Proposal**

After admission to the Department as a Classified or Conditionally Classified graduate student, the student in consultation with the Thesis Chair must prepare her/his Thesis Proposal and Program of Study, which includes all coursework to be taken. The Thesis Proposal must include a thorough review of relevant primary literature that demonstrates the context of the proposed research, it must clearly define the experiments proposed for the research to be undertaken, and should include preliminary data, if available. The student and her/his Thesis Chair will select at least two additional members to serve on the Thesis Committee. In most

cases, the Thesis Advisor will serve as Chair of the Thesis Committee. However, if the Thesis Advisor is not eligible, another member of the Thesis Committee will serve as Thesis Committee Chair. The student will then have a formal meeting with the Thesis Committee, at which the student's Thesis Proposal and Program of Study will be presented and evaluated. At this meeting, the Thesis Committee will question the student about her/his Thesis Proposal. At the completion of this meeting, the Thesis Committee will meet briefly, without the student present, to evaluate the Thesis Proposal. Approval is based on whether the student has demonstrated a solid understanding of her/his thesis project. The Thesis Proposal must be prepared, presented to, and approved by the Thesis Committee before the end of the second semester after admission to the Department. Failure to meet this requirement will result in dismissal from the M.S. in Biology program.

### **The Program of Study**

The Program of Study must include completion of a minimum of 30 semester units. At least 20 of these units must be in the 500-600 level courses of which a minimum of 16 units must be in the Microbiology 500-600 series. Required courses, if not taken previously, include MICR 371 or an upper division/graduate course in genetics; MICR 471 or an upper division/graduate course in cell physiology; MICR 661 (two enrollments with different topics for a total of 4 units is required), or MICR 661 and BIOL 663; BIOL 696A (2 units), BIOL 696B (2 units), MICR 697 (maximum 3 units); and MICR 698 (6 units). Other elective units included in the graduate program must be 400-600 level courses acceptable to the University and microbiology degree program. Up to 5 units of 300-level courses may be included with an approval from the Thesis Chair and Graduate Advisor. BIOL 696A will be taken during the student's initial fall semester; the course will cover experimental design, statistics, and literature research, and help students in preparing their Thesis Proposal. BIOL 696B will be taken during the first spring semester in the program, and will cover both oral and written scientific presentation. BIOL 696B is intended to facilitate manuscript and thesis writing and to help students learn to articulate their findings for their thesis defense.

### **Advancement to Candidacy**

The regulations governing the master's degree are those in effect at the time of advancement to candidacy. In addition to the general university requirements stated previously under Post-Baccalaureate and Graduate Degrees in this catalog, the student must complete the following steps before receiving Candidate status in the Department of Biological Sciences:

1. Admission to the Department of Biological Sciences' Master's Degree program as a Classified graduate student (see above);
2. Acceptance of the Thesis Proposal and Program of Study by the Thesis Committee;
3. Satisfactory academic progress;
4. Satisfactory fulfillment of the Graduate Writing Assessment Requirement (GWAR).

The Thesis Committee will recommend the student for advancement to candidacy by forwarding its recommendation to the department Graduate Advisor. This should occur at

end of second semester after admission. Upon approval by the College's Associate Dean, the student will attain Master's Candidate status.

### **Requirements for the Master of Science in Microbiology**

In addition to the general University requirements stated previously in this catalog, the student must meet the following requirements before receiving the degree of Master of Science in Microbiology.

1. Advancement to candidacy (see above);
2. Maintenance of a 3.00 ("B" average) or better, overall graduate grade point average (includes all upper-division and graduate level courses taken since admission to this University and after completion of the baccalaureate degree) and graduate program GPA. If either GPA falls below 3.00, it must be elevated to a 3.00 by the end of the following semester or the student will be dropped from the M.S. in Microbiology program;
3. Successful completion of the following: written thesis and public defense followed by a private defense with the Thesis Committee; and
4. Serve as a teaching associate or graduate assistant. Under some circumstances, this requirement may be waived.

Requests to graduate must be received by Enrollment Services approximately 6 months in advance of the expected graduation date (check the *Schedule of Classes* for the date).

These requirements must be completed within 6 years from when the first course on the Program of Study was completed, including academic leaves, or the student's degree program will be terminated.

### **Single Subject Teaching Credential in Biology**

For information, refer to the undergraduate section in this department..

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## **Biology Courses (BIOL)**

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Students pursuing a major and/or a minor in this department may receive unit credit for courses marked with the symbol '##' as a general elective but may not apply the units toward the specific or elective requirements for any degree or option in this department. Majors in this department may, however, take, for general education purposes, interdisciplinary courses offered by this department. All other courses in this department are open to majors and minors but by letter grade only (A-F).

### **LOWER DIVISION**

#### **100.## Biology of the Human Environment (3) F,S**

Prerequisite/Corequisite: One GE Foundation course.

Biological perspective on the interaction between humans and their environment. Specially designed for non-science majors.

(Lecture 3 hrs.)

#### **153. Introduction to Marine Biology (3) F,S**

Prerequisites/Corequisites: Courses that fulfill the A.1 and B.2 GE requirements.

Scientific approach to the study of marine organisms and their relationships to the environment. Emphasis on human interaction with marine ecosystems.

(Lecture 2 hrs., laboratory and field 3 hrs.) Field trips may be required outside of scheduled class time. Not open for credit to students with credit in BIOL 201.

#### **153L. Introduction to Marine Biology Laboratory (1) F,S**

Prerequisite: Open only to students who have successfully completed the equivalent of the lecture portion of BIOL 153 at another accredited institution and have consent of the Department of Biological Sciences.

Identical to the laboratory portion of BIOL 153. Students enrolled in BIOL 153L will take it in the same room and at the same time as students enrolled in BIOL 153. Not open for credit to students with credit in BIOL 153. (Laboratory 3 hrs.)

#### **200.## General Biology (4) F,S**

Prerequisite: GE Foundation requirements.

Brief survey of major areas of biology including cell biology, genetics, evolution, phylogeny, plant and animal anatomy and physiology, ecology, and behavior. Specially designed for non-science majors.

Course fee may be required. (Lecture 3 hrs., laboratory 3 hrs.)

#### **200L.## General Biology Laboratory (1) F,S**

Prerequisite: Open only to students who have successfully completed the equivalent of the lecture portion of BIOL 200 at another accredited institution and have consent of the Department of Biological Sciences.

BIOL 200L is identical to the laboratory component of BIOL 200. Students enrolled in BIOL 200L will take it in the same room and at the same time as students enrolled in BIOL 200.

Not open for credit to students with credit in BIOL 200. Course fee may be required. (Laboratory 3 hrs.)

#### **205.## Human Biology (4) F,S**

Prerequisites: GE Foundation requirements.

Brief survey of human biology focusing on anatomy, physiology, and development of cells, tissues, organs, and organ systems; including molecular biology, genetics, ecology, evolution, and diversity. Specially designed for non-science majors.

Not open for credit to students with credit in A/P 107 or 205. Course fee may be required. (Lecture 3 hrs., laboratory 3 hrs.)

#### **205L.## Human Biology Laboratory (1) F,S**

Prerequisite: Open only to students who have successfully completed the equivalent of the lecture portion of BIOL 205 at another accredited institution and have consent of the Department of Biological Sciences. Identical to the laboratory portion of BIOL 205. Students enrolled in BIOL 205L will take it in the same room and at the same time as students enrolled in BIOL 205.

Not open for credit to students with credit in BIOL 205. Course fee may be required. (Laboratory 3 hrs.)

#### **207.## Human Physiology (4) F,S**

Prerequisites: GE Foundation requirements.

General introduction to the functional integration of human body systems. Designed for majors in biomedical engineering, physical education, and the allied health fields.

Not open for credit to students with credit in A/P 207 or 209. (Lecture 3 hrs., laboratory 3 hrs.) Course fee may be required.

#### **208.## Human Anatomy (4) F,S**

Prerequisites: GE Foundation requirements.

Gross anatomy of humans from the cellular to the systemic levels. Intensive laboratory experience including the use of human cadavers. Designed for majors in kinesiology and the allied health fields.

Not open for credit to students with credit in A/P 202 or 208. (Lecture 3 hrs., laboratory 3 hrs.) Course fee may be required.

#### **211. Introduction to Evolution and Diversity (4) F,S**

Prerequisite/Corequisite: CHEM 111A with a grade of "C" or better.

Intended for natural science majors. First of three semester introductory sequence. Evolution as a process responsible for biological diversity at all levels: molecular, cellular, organismal, population, and community. Phylogenetic and taxonomic survey of life. Science as method of inquiry. Failure of either the lecture or the laboratory component will result in a failing grade for the entire course.

Not open to students with credit in BIOL 111. Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.) Course fee may be required.



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## Biology Courses (BIOL)

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### 211L. Introduction to Evolution and Diversity Laboratory (1) F,S

Prerequisites: Open only to students who have successfully completed the equivalent of the lecture component of BIOL 211 at another accredited institution and have consent of the Department of Biological Sciences.

Phylogenetic and taxonomic survey of life emphasizing the principles of evolution and science as a method of inquiry. Identical to the laboratory component of BIOL 211. Students enrolled in BIOL 211L will take it in the same room and at the same time as students enrolled in BIOL 211.

Not open to students with credit in BIOL 111L. Letter grade only (A-F). (Laboratory 3 hrs.) Course fee may be required.

### 212. Introduction to Cell and Molecular Biology (4) F,S

Prerequisites: BIOL 211, CHEM 111A with grades of "C" or better. Prerequisite/Corequisite: CHEM 111B.

The second of a three semester introductory sequence. Introduction to macromolecular and cellular structure and function and to fundamental genetic principles. Failure of either the lecture or laboratory component will result in a failing grade for the entire course.

Not open to students with credit in BIOL 211A. Letter grade only (A-F). (Lecture 3 hrs., laboratory 3hrs.) Course fee may be required.

### 212L. Introduction to Cell and Molecular Biology Laboratory (1) F,S

Prerequisites: Open only to students who have successfully completed the equivalent of the lecture component of BIOL 212 at another institution and have consent of the Department of Biological Sciences.

Introduction to methods for studying macromolecular and cellular structure and function and fundamental genetic analyses. Identical to the laboratory component of BIOL 212. Students enrolled in BIOL 212L will take it in the same room and at the same time as students enrolled in BIOL 212.

Letter grade only (A-F). Not open to students with credit in BIOL 211A or 211C. (Laboratory 3 hrs.) Course fee may be required.

### 213. Introduction to Ecology and Physiology (4) F,S

Prerequisites: BIOL 211, 212, CHEM 111B, each with a grade of "C" or better.

The third of a three semester introductory sequence. Introduction to the functional biology of plants and the abiotic and biotic factors that affect their distribution and abundance. Failure of either the lecture or the laboratory component will result in failing grade for the entire course.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.) Not open to students with credit in BIOL 211B. Course fee may be required.

### 213L. Introduction to Ecology and Physiology Laboratory (1) F,S

Prerequisites: Open only to students who have successfully completed the equivalent of the lecture component of BIOL 213 at another institution and have consent of the Department of Biological Sciences.

Introduction to methods for studying plant and animal structure and function and the interactions among organisms and their environments. Identical to the laboratory component of BIOL 213. Students enrolled in BIOL 213L will take it in the same room and at the same time as students enrolled in BIOL 213.

Letter grade only (A-F). Not open to students with credit in BIOL 211B or 211D. (Laboratory 3 hrs.) Course fee may be required.

### 260. Biostatistics (3) F,S

Prerequisites: BIOL 211 or BIOL 207 or MICR 200; MATH 111 or 113 or 119A or 122 all with a grade of "C" or better.

Probability and statistics used in the description and analysis of biological data.

Letter grade only (A-F). (Lecture 2 hrs., laboratory 3 hrs.) Course fee may be required.

### 296. Introduction to Undergraduate Directed Research (1) F,S

Prerequisites: Consent of instructor.

Introduction to research in biology approved and directed by a faculty member in the Department of Biological Sciences. Designed primarily to introduce lower division students to research before taking MICR/BIOL 496.

Credit/No Credit only. May be repeated to a maximum of 3 units in different semesters. Same course as MICR 296. Not open for credit to students with credit in MICR 296. Students who have completed one or more units of MICR/BIOL 496 may not enroll in this course. (Conference 1 hr., laboratory 3 hrs.)

## UPPER DIVISION

### 301.## Biology of Human Aging (3)

Prerequisite: BIOL 200 or 205 or 207 all with a grade of "C" or better.

Biological processes associated with aging in humans. Emphasis on both cellular and organ aging.

Specifically designed for the gerontology program. Not open to students with "C" or better in BIOL 401. (Lecture 3 hrs.)

### 304.## Pathophysiology (3) F,S

Prerequisites: BIOL 207, 208; CHEM 140; MICR 200, all with a grade of "C" or better.

Pathogenesis and pathophysiology of common disorders of human nervous, musculoskeletal, endocrine, cardiovascular, respiratory, excretory, digestive, and reproductive systems with emphasis on the physiological basis of the disease process and clinical correlations.

Not designed for majors in the College of Natural Sciences and Mathematics. Priority registration given to students who have been accepted into CSULB nursing programs.

(Lecture 3 hrs.)

### 305.## Pharmacology (2) F,S

Prerequisite/Corequisite: BIOL 304, with a grade of "C" or better.

Systematic study of drugs, their classification, methods and routes of administration, therapeutic and toxic effects with emphasis on nursing implications.

Not designed for majors in the College of Natural Sciences and Mathematics. Not open for credit to students with a "C" or better in BIOL 204. Priority registration given to students who have been accepted into CSULB nursing programs. (Lecture 2 hrs.)

### 308.## Issues in Women's Health (3)

Prerequisites: Upper division standing; ENGL 100 or GE Composition (Area A1); and WGSS 101, BIOL 205, BIOL 207, or BIOL 213.

Fundamentals of anatomy and physiology relevant to the cause/prevention/treatment of various health issues, including reproductive organ dysfunction, sexually-transmitted disease, infertility, contraception, pregnancy, osteoporosis, cancer, and cardiovascular disease. Lifestyle habits (diet, exercise, stress, etc.) will be emphasized throughout.

(Lecture 3 hrs.)

### 312. Evolutionary Biology (3) F,S

Prerequisites: BIOL 211, 212, 213, 260 all with a grade of "C" or better.

Survey of evolutionary biology including population genetics, speciation, origin of life, and phylogenetic analysis. Main emphasis is evolutionary mechanisms and methods of analysis on specific of the evolutionary history of life.

Letter grade only (A-F). (Lecture 3 hrs.)

### **313. Invertebrate Zoology (4) F,S**

Prerequisites: BIOL 211, 212, 213 all with a grade of "C" or better.

Systematics, morphology, and natural history of invertebrate animals, with emphasis on local marine forms.

Letter grade only (A-F). (Lecture 2 hrs., laboratory and field 6 hrs.; weekend field trips may be required.) Course fee may be required.

### **316. General Entomology (4) F,S**

Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better.

Characteristics, structure, habits, and life cycles of insects; importance of insects to humans and other organisms.

Letter grade only (A-F). (Lecture 2 hrs., laboratory 6 hrs.) Course fee may be required.

### **324. Vertebrate Zoology (4) F,S**

Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better.

Phylogenetic survey of vertebrates (craniates). Lecture concentrates on origin and radiation of vertebrates and their functional morphology. Laboratory concentrates on skeletal and internal anatomy and taxonomy to the ordinal and familial level of living vertebrates.

Letter grade only (A-F). (Lecture 2 hrs., laboratory 6 hrs.) Course fee may be required.

### **340. Molecular Cell Biology (3) F,S**

Prerequisites: BIOL 211, 212; CHEM 320A or 322A or 327 all with a grade of "C" or better.

Detailed study of the organization and functioning of cells and cellular organelles at the molecular level; emphasis on experimental approaches and structural/functional relationships.

Letter grade only (A-F). (Lecture 3 hrs.)

### **341. Physiology for Therapists I (4) F,S**

Prerequisites: BIOL 211, 212, 213; CHEM 111A,B; PHYS 100A,B all with grade of "C" or better; 100 hours of documented exposure to the practice of physical therapy in a variety of settings; and consent of instructor.

Mechanisms of action and interaction of physiological body systems with emphasis on nervous and endocrine systems and skeletal and smooth muscle. Pathological and clinical considerations presented.

Letter grade only (A-F). Course fee may be required. (Lecture 3 hrs., laboratory 3 hrs.)

### **342. Human/Mammalian Physiology (3) F,S**

Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better. Recommended: PHYS 100A,B.

Function of various mammalian body systems, primarily of humans. Emphasis on integration of homeostatic mechanisms of nervous, muscular, endocrine, cardiovascular, respiratory, renal, digestive, and reproductive systems.

Letter grade only (A-F). (Lecture 3 hrs.)

### **342L. Laboratory in Human/Mammalian Physiology (1) F,S**

Prerequisite/Corequisite: BIOL 342 with a grade of "C" or better.

Experiments and exercises designed to provide experience in, and illustration of, physiological principles and mechanisms of interaction among various body systems.

Letter grade only (A-F). Course fee may be required. (Laboratory 3 hrs.)

### **345. Comparative Animal Physiology (3) F,S**

Prerequisites: BIOL 211, 212, 213 all with grade of "C" or better.

Comparison of fundamental physiological processes of major animal phyla.

Not open for credit to students with credit in A/P 340. Letter grade only (A-F). (Lecture 3 hrs.)

### **345L. Laboratory in Comparative Animal Physiology (1) F,S**

Prerequisite/Corequisite: BIOL 345 with a grade of "C" or better.

Laboratory course acquaints students with direct observation and measurement of physiological processes in various animal groups, both invertebrate and vertebrate.

Letter grade only (A-F). Course fee may be required. (Laboratory 3 hrs.)

### **350. General Ecology (3) F,S**

Prerequisites: BIOL 211, 212, 213, 260; MATH 119A or 122 all with a grade of "C" or better. Chemistry and physics recommended.

Relationships of plants and animals to their physical and biological environment; structure and function of populations, communities and ecosystems.

Letter grade only (A-F). (Lecture 3 hrs., and two required Saturday field trips.)

### **353. Marine Biology (3) S**

Prerequisites: BIOL 153, 211, 212, 213, 260 all with grade of "C" or better.

Study of pelagic and benthic marine ecosystems, including food resources, mariculture, and pollution. Weekend field trips may be required.

Letter grade only (A-F). (Lecture 2 hrs., laboratory and field 3 hrs.)

Course fee may be required.

### **355. Microbial Ecology (3) S**

Prerequisites: MICR 211 or BIOL 211, 212, 213 all with a grade of "C" or better.

Explores relationships of microorganisms to their environment. Emphasis placed on ecological basis for diversity of prokaryotic forms, metabolic functions and community interactions.

Letter grade only (A-F). Same course as MICR 355. Not open for credit to student with credit in MICR 355. (Lecture 3 hrs.)

### **355L. Microbial Ecology Laboratory (1) S**

Prerequisite/Corequisite: BIOL 355 or MICR 355.

Provides an understanding of microbes in the environment. Sample and analyze microbes from field trips to different habitats. Analytical techniques learned include enrichment culture methods and modern molecular biology methods to study the diversity and community dynamics of microbes.

Letter grade only (A-F). Course fee may be required. Same course as MICR 355L. Not open for credit to student with credit in MICR 355L. (Laboratory 3 hrs.)

### **370. General Genetics (4) F,S**

Prerequisites: BIOL 211, 212 and either BIOL 260 or CHEM 251 all with a grade of "C" or better.

Detailed study of classical transmission genetics and introduction to modern molecular genetics. Includes current observations and concepts of nature, organization, function, and regulation of genetic expression.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.) Course fee may be required.

### **411./511. Marine Mammalogy (3) S, odd years**

Prerequisite(s): BIOL 345, 350, and 353, all with grade of "C" or better, and consent of instructor. (Undergraduates enroll in BIOL 411; graduates enroll in BIOL 511.)

Fundamental biological, ecological, and physiological concepts of marine mammals, including cetaceans, pinnipeds, walrus, sirenians, and polar bears. Information concerning taxonomy, distribution, morphology, physiology, reproduction, and feeding through readings and scientific literature.

Fieldtrips may include weekends and spring recess. Letter grade only (A-F). (Lecture 2 hrs., laboratory and fieldtrips 3 hrs.)

### **412./512. Advanced Evolutionary Biology (3)**

Prerequisite: BIOL 312 with a grade of "C" or better. (Undergraduates enroll in BIOL 412; graduates enroll in BIOL 512.)

An advanced survey of topics in evolutionary biology including but not limited to population and quantitative genetics, allometry, game theory, evolutionary psychology, and evolutionary-developmental biology. Main emphasis on the development of conceptual and mathematical models of evolutionary processes.

Letter grade only (A-F). (Lecture 3 hrs.)

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## Biology Courses (BIOL)

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### 415./515. Marine Microbiology (3) F, odd years

Prerequisite: BIOL 353 or MICR 355 or BIOL 355 with a grade of "C" or better. (Undergraduates enroll in BIOL 415; graduates enroll in BIOL 515.)

Designed to familiarize microbiology and marine biology students with the role of microorganisms in the marine environment. Topics will include ecology, physiology, biogeochemistry and diversity of marine microbes. Laboratory/field component will emphasize examination and cultivation of local marine microbes.

Letter grade only (A-F). Same course as MICR 415. Not open for credit to students with credit in MICR 415. Course fee may be required. (Lecture 2 hrs., laboratory and field 3 hrs., weekend field trip may be required.)

### 416./516. Virology (3) F,S

Prerequisite: MICR 320 or BIOL 340 with a grade of "C" or better. (Undergraduates enroll in BIOL 416; graduates enroll in BIOL 516.)

Virology at molecular level including viral replication and molecular basis for viral pathogenesis; survey of human, animal, and plant viral diseases. Current trends for prevention and treatment of viral diseases.

Letter grade only (A-F). Same course as MICR 416. Not open for credit to students with credit in MICR 416. (Lecture 3 hrs.)

### 419. Ichthyology (3) F

Prerequisites: BIOL 211, 212, 213, 260 and at least 6 additional units of upper division biological science, all with a grade of "C" or better. Recommended: BIOL 350, 353, and 370.

Systematics, morphology, genetics, and ecology of fishes. Emphasis on local marine forms.

Letter grade only (A-F). (Lecture 2 hrs., laboratory 3 hrs., weekend field trips may be required.) Course fee may be required.

### 420./520. Fisheries Ecology and Conservation (3) F

Prerequisite(s): BIOL 260, 350, 353, and 419, all with grade of "C" or better. (Undergraduates enroll in BIOL 420; graduates enroll in BIOL 520.)

Advanced aspects of fish and invertebrate biology and behavior; fisheries economics and conservation; emphasis on state-of-art field/laboratory techniques and contemporary concepts and their application in fishery management.

Letter grade only (A-F). (Lecture 2 hrs., laboratory and field 3 hrs.)

### 421. Herpetology (3) S, odd years

Prerequisites: BIOL 260, 350, and one additional upper division biology course, all with a grade of "C" or better. Recommended: BIOL 312, 324, or 370.

Taxonomy, natural history, ecology and distribution of amphibians and reptiles, emphasis on local forms. Weekend field trip required.

Letter grade only (A-F). (Lecture 2 hrs., laboratory and field 3 hrs.)

### 423. Mammalogy (3)

Prerequisites: At least one of BIOL 312, 324, or 350, with a grade of "C" or better.

Explores the biology and diversity of the world's living mammals. Lecture emphasizes radiation of orders; their morphology, physiology, evolutionary history, ecology and behavior. Laboratory emphasizes external and skeletal morphology of these same taxa, identification of California species, and a focus on techniques in mammalogy.

Letter grade only (A-F). (Lecture 2 hrs., laboratory 3 hrs.)

### 424./524. Ornithology (3) S

Prerequisites: BIOL 211, 212, 213, 260 and three units of upper division BIOL, all with a grade of "C" or better. Recommended: BIOL 350. (Undergraduates enroll in BIOL 424; graduates enroll in BIOL 524.)

Ecology, morphology, physiology, behavior, and taxonomy of birds from an evolutionary perspective, also factors influencing recent increase in their extinction risk. Species identification techniques (emphasis on the local avifauna) and methods of surveying avian populations.

Letter grade only (A-F). (Lecture 2 hrs., laboratory/field 3 hrs.) Course fee may be required.

### 425. Phycology (4) F,S

Prerequisite: BIOL 353 with a grade of "C" or better.

Taxonomy, phylogeny, and physiology of algae, including the physiological ecology of marine macroalgae; emphasis on local marine forms.

Letter grade only (A-F). (Lecture 3 hrs., laboratory and field 3 hrs.)

### 427. Vascular Plant Systematics (4) S

Prerequisite: BIOL 312 or 370 with a grade of "C" or better.

Principles and methods of plant systematics, including phylogenetics, different types of systematic data, evolutionary history and diversification of vascular plants. Laboratory emphasizes retrieving and analyzing systematic data, using phylogenetic methods, and identifying vascular plants of Southern California.

Letter grade only (A-F). Course fee may be required. (Lecture 2 hrs., laboratory and field 6 hrs.)

### 430. Immunology (3) F,S

Prerequisite: BIOL 340 with a grade of "C" or better.

Study of cellular and molecular components of immune system, including how immune system recognizes pathogens, how it functions in various types of immune responses, mechanisms of vaccines, immunodeficiencies, transplantation, allergy, and autoimmunity.

Letter grade only (A-F). Same course as MICR 430. Not open for credit to students with credit in MICR 430. (Lecture 3 hrs.)

### 431./531. Biology of Cancer (3) F,S

Prerequisites: BIOL 340, 370 with a grade of "C" or better. (Undergraduates enroll in BIOL 431, graduates enroll in BIOL 531.)

Examination of cancer, tumor progression, and treatment at the cellular, molecular, and genetic levels.

Letter grade only (A-F). (Lecture 3 hrs.)

### 432./532. Stem Cell Biology (3) S

Prerequisites: BIOL 433 or 533 with a grade of "C" or better. (Undergraduates enroll in BIOL 432; graduates enroll in BIOL 532.)

Current literature on advances in stem cell research, translational research, and clinical applications of stem cells to alleviate human disease.

Letter grade only (A-F). (Lecture 3 hrs.)

### 432L./532L. Advanced Stem Cell Laboratory (4) SS

Prerequisites: BIOL 432/532, 440L, 462/562, 473/573, 477/577, all with a grade of "C" or better, and consent of the director of the CSULB Biotechnology Certificate Program. (Undergraduates enroll in BIOL 432L; graduates enroll in BIOL 532L.)

Intensive laboratory, offered during a 6-week summer session. Students learn basic and advanced stem cell culture techniques. The sixth week is 40 hours at the Children's Hospital of Orange County Research Institute (CHOC).

Letter grade only (A-F). (Lecture 1 hr., laboratory 9 hrs.)

### 433./533. Developmental Biology (3) F,S

Prerequisites: BIOL 340, and either BIOL 370 or MICR 371, both with a grade of "C" or better. (Undergraduates enroll in BIOL 433; graduates enroll in BIOL 533.)

Experimental approaches to development in model organisms, mostly animal, at the molecular, genetic, cellular, and tissue levels. Topics include gametogenesis, fertilization, early cleavage, gastrulation, pattern formation, and organogenesis.

Letter grade only (A-F). (Lecture/discussion 3 hrs.)

### **439. Plant Morphology (4) F**

Prerequisite: BIOL 312 or 370 with a grade of "C" or better.

A phylogenetic survey of green plant morphological diversity and analysis of the developmental and genetic mechanisms affecting this diversity. Emphasis in the laboratory is on documenting green plant morphological evolution, bioinformatics, and studying the developmental mechanisms driving morphological diversification.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.) Course fee may be required.

### **440L. Molecular Cell Biology Laboratory (3) F**

Prerequisites: BIOL 340, 370, both with a grade of "C" or better, and consent of instructor. (Preference given to students in the Bachelor of Science in Biology, Option in Cell and Molecular Biology.)

Intensive course of modern laboratory techniques used in both cell and molecular biology. Topics include genomics, subcellular structure and transport, and purification and functional characterization of recombinant proteins. Provides extensive laboratory experience for students.

Letter grade only (A-F). (Lecture 1 hr., laboratory 6 hrs.) Course fee may be required. Not open for credit to students with credit in BIOL 340L.

### **441. Physiology for Therapists II (3) F,S**

Prerequisite: BIOL 341 with a grade of "C" or better.

Mechanisms of action and interaction of physiological body systems with emphasis on cardiovascular, renal, and respiratory systems. Pathological and clinical considerations will be presented.

Letter grade only (A-F). (Lecture 3 hrs.)

### **442./542. Physiology at the Limit (3)**

Prerequisites: BIOL 342 or 345 with a grade of "C" or better. (Undergraduates enroll in BIOL 442; graduates enroll in BIOL 542.)

Survey of physiological adaptations of animals in conditions of extreme performance and environmental limitations. Topics include individual and evolutionary responses to high-altitude, deep-sea diving, outer space and micro-gravity, exercise, flight, swimming, and extreme temperatures. Examples from vertebrates and invertebrates.

Letter grade only (A-F). (Lecture 3 hrs.)

### **443./543. Endocrinology (3) F,S**

Prerequisites: BIOL 340 or CHEM 441B; CHEM 320A or 322A or 327; and one of BIOL 341, 342, 345, 445, 448; CHEM 441A or 448, all with a grade of "C" or better. (Undergraduates enroll in BIOL 443; graduates enroll in BIOL 543.)

Role of endocrines in vertebrate and invertebrate adjustment to changes in internal and external environment.

Letter grade only (A-F). (Lecture 3 hrs.)

### **444./544. Reproductive Biology (3) S**

Prerequisite: BIOL 342 or 345 with a grade of "C" or better. (Undergraduates enroll in BIOL 444; graduates enroll in BIOL 544.)

Topics in comparative reproductive biology from molecular, cellular, organismal, and population levels. Hormones and reproduction, gamete/gonad biology, reproductive lifespan, mating system/strategies, environmental influence on reproductive capabilities, contraception/*in vitro* fertilization. Scientific communication discussed including scientific articles and scientific writing.

Letter grade only (A-F). (Lecture 3 hrs.)

### **445./545. Metabolic Regulation (3) F**

Prerequisites: BIOL 340, 342 or 345; CHEM 441A with grade of "C" or better. (Undergraduates enroll in BIOL 445; graduates enroll in BIOL 545.)

Study of molecular mechanisms by which intermediary metabolism is regulated in various mammalian tissues with emphasis on mechanisms of hormone action and regulation of some key enzymes of carbohydrate, fat, and protein metabolism.

Letter grade only (A-F). (Lecture 3 hrs.)

### **447./547. Molecular Plant Physiology (3) S**

Prerequisites: BIOL 340, 370, both with grade of "C" or better. (Undergraduates enroll in BIOL 447; graduates enroll in BIOL 547.)

Molecular approaches to classical topics including plant hormones, photosynthesis, resistance to plant pathogens, adaptation of plants to environmental stress, and development of plants.

Letter grade only (A-F). (Lecture 3 hrs.)

### **448./548. Principles of Neurobiology (3) F,S**

Prerequisites: BIOL 340 or CHEM 441B and one of BIOL 341, 342, or 345 all with a grade of "C" or better. (Undergraduates enroll in BIOL 448; graduates enroll in BIOL 548.)

Study of the principles of anatomy, physiology, and function of the nervous system. Topics covered include neuroanatomy, physiology of neuronal signaling (excitable membranes and action potentials), synaptic transmission, neurotransmitters and their receptors, pain processing, special senses, reflexes, and neural circuits.

Letter grade only (A-F). (Lecture 3 hrs.)

### **449./549. Fish Physiology and Endocrinology (3)**

Prerequisite: BIOL 345 with grade of "C" or better. (Undergraduates enroll in BIOL 449; graduates enroll in BIOL 549.)

Fundamentals of physiological systems and strategies in fishes, with emphasis on endocrine regulatory mechanisms. Adaptations in endocrine physiology of fishes considered from evolutionary and ecological perspectives. Impacts of human activities, particularly in context of Southern California's marine environment addressed.

Letter grade only (A-F). (Lecture 3 hrs.)

### **450./550. Plant Ecology (3) S, even years**

Prerequisites: BIOL 260, 350 with a grade of "C" or better. Recommended: BIOL 427, 447. (Undergraduates enroll in BIOL 450; graduates enroll in BIOL 550.)

Relationship of plants to their environment and principles of plant distribution.

Letter grade only (A-F). (Lecture 2 hrs., laboratory and field 3 hrs.) Course fee may be required.

### **451./551. Wetlands and Mangrove Ecology (3) S, odd years**

Prerequisites: BIOL 260, 350 both with a grade of "C" or better. (Undergraduates enroll in BIOL 451; graduates enroll in BIOL 551.)

A comprehensive look at wetland ecology and management. Focuses on physical, biogeochemical, and ecological aspects of major wetland ecosystems with an emphasis on local urban wetlands. Also includes wetland management concepts and approaches worldwide.

Letter grade only (A-F). (Lecture 2 hrs., laboratory and field 3 hrs.)

### **452./552. Behavioral Ecology (3)**

Prerequisites: BIOL 211, 212, 213, 260 all with a grade of "C" or better. Prerequisite/Corequisite: BIOL 312 or 350. (Undergraduates enroll in BIOL 452; graduates enroll in BIOL 552.)

Primary objectives are to understand how animal behavior affects survival and reproduction and introduce students to current methodologies to study behavior of animals in lab and field conditions. Emphasizes ecological and evolutionary consequences of behavior across taxa.

Letter grade only (A-F). (Lecture 2 hrs., laboratory/field 3 hrs.)

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## Biology Courses (BIOL)

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### 453./553. Insect Ecology (3) F, even years

Prerequisite: BIOL 350 with a grade of "C" or better. (Undergraduates enroll in BIOL 453; graduates enroll in BIOL 553.)

Field and experimental studies of abundance, dispersal, distribution, and behavior of insects.

Letter grade only (A-F). (Lecture 2 hrs., laboratory and field 3 hrs.)

### 454A./554A. Research in Tropical Marine Ecology (3) S, even years

Prerequisite(s): BIOL 350, 353, and one of BIOL 313 or 419 or 425, all with grade of "C" or better, and consent of instructor. (Undergraduates enroll in BIOL 454A; graduates enroll in BIOL 554A.)

Field and laboratory studies, lectures, and individual research on tropical marine biological problems. Designed to engage students in experimental research, including: recognizing a problem, designing and carrying out a project, statistical data analysis, and oral and written report presentation.

Eight-day field trip to Hawaii required during spring recess at student expense. Enrollment is limited. Letter grade only (A-F). Course fee may be required. (Lecture 2 hrs., 8 day field trip.)

### 454B./554B. Research in Tropical Terrestrial Ecology (3) S, odd years

Prerequisites: BIOL 350; one of BIOL 316, 324, 421, 424, 427, or 439 all with a grade of "C" or better; and consent of instructor. (Undergraduates enroll in BIOL 454B; graduates enroll in BIOL 554B.)

Field-based comparison of tropical lowland deciduous forest and lowland rainforest incorporating basic ecology methodology. Forest structure and diversity of animals emphasized. Students maintain field notebook, submit final paper, and give oral presentation.

Nine-day fieldtrip to Costa Rica required during spring recess at student expense. Enrollment is limited. Letter grade only (A-F). Course fee may be required. (Lecture 2 hr., 9 day field trip.)

### 455./555. Ecology of Marine Communities (3) F, even years

Prerequisites: BIOL 260, 350, 353 all with a grade of "C" or better. (Undergraduates enroll in BIOL 455; graduates enroll in BIOL 555.)

Field studies on ecological principles related to marine communities discussed. Includes individual field research project and two class projects.

Letter grade only (A-F). (Lecture 2 hrs., field 3 hrs.)

### 456./556. Population Ecology (3) S, even years

Prerequisites: BIOL 350, MATH 119B or 123 all with a grade of "C" or better. (Undergraduates enroll in BIOL 456; graduates in BIOL 556.)

Analysis of animal and plant populations characteristics: population growth and regulation, fluctuation and regulation, competition, predation, parasitism, and other intraspecific and interspecific interactions; spatial patterns.

Letter grade only (A-F). (Lecture 3 hrs.)

### 457./557. Field Methods in Ecology (3)

Prerequisites: BIOL 260, 350 both all with a grade of "C" or better. (Undergraduates enroll in BIOL 457; graduates in BIOL 557.)

Design of field research projects, collection, and data analysis, report writings and presentations. Field sampling techniques emphasized. Five weekend fieldtrips required.

Letter grade only (A-F). (Lecture 2 hrs., laboratory and field 3 hrs.)

### 459./559. Conservation Biology (3) F

Prerequisites: BIOL 260, 350 both with a grade of "C" or better. Recommended: BIOL 370. (Undergraduates enroll in BIOL 459; graduates enroll in BIOL 559.)

Conservation biology concepts including population dynamics, extinction processes, population viability analyses, metapopulations,

community-level interactions, island biogeography, biological diversity patterns, habitat fragmentation, reserve design, and landscape-level conservation. Lecture includes group discussions of case studies and relevant primary literature.

Letter grade only (A-F). (Lecture 3 hrs.) 20 hrs. per semester service learning for undergraduates, extra research paper for graduates.

### 462./562. Bioethics and Public Policy (3) S

Prerequisites: BIOL 340 with a grade of "C" or better. (Undergraduates enroll in BIOL 462; graduates enroll in BIOL 562.)

History of bioethics, scientific and medical bases of key bioethical issues, current legislation and appropriations, including legal, social, and ethical implications of stem cell research and other biotechnological advances.

Letter grade only (A-F). (Lecture 3 hrs.)

### 463./563. Computer Modeling in Biology (4)

Prerequisites: BIOL 260, 350 both with a grade of "C" or better. (Undergraduates enroll in BIOL 463; graduates enroll in BIOL 563.)

History, modeling theory, different modeling approaches, theoretical, empirical and quantitative modeling. Laboratory uses modeling software and focuses on model construction and quantitative simulation. Applicable to ecology, microbiology, physiology, environmental sciences, etc.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.) Course fee may be required.

### 464./564. Aquatic Toxicology (3)

Prerequisites: BIOL 211, 212, 213, 340; CHEM 320A or 322A or 327, all with a grade of "C" or better. Recommended: BIOL 353 and CHEM 448 or 441A,B. (Undergraduates enroll in BIOL 464; graduates enroll in BIOL 564.)

In depth study of interactions between anthropogenic chemicals and aquatic ecosystems, including origin, fate, chemical and biological detection, and quantification of pollutants and impact at molecular, biochemical, cellular, physiological, organismal, and community levels of organization. Individual research project required.

Letter grade only (A-F). (Lecture 3 hrs.)

### 465./565. Experimental Design and Regression Analysis (4) F, even years

Prerequisites: BIOL 260; MATH 119B or 123; 6 units of upper division biological science all with a grade of "C" or better. (Undergraduates enroll in BIOL 465; graduates enroll in BIOL 565.)

Experimental design and data analysis techniques applied to problems in biology including analysis of variance and covariance, bivariate and multiple regression, experimental design, bootstrapping and randomization tests, and nonparametric statistics. Experience in analyzing biological data using computerized statistical packages.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.)

### 466. Research Design and Methods (3) S

Prerequisites: BIOL 211, 212, 213, either BIOL 260 or CHEM 251, CHEM 320A,B or CHEM 322A,B and CHEM 323A,B all with a grade of "C" or better; GE Foundation requirements; a GPA of at least 3.0 in the major; and consent of the instructor. At least one unit of BIOL 496 or CHEM 496.

Corequisites: At least one unit of BIOL 496 or CHEM 496.

Introduction to hypothesis testing, experimental design, methodological and technical procedures for experimentation, grant writing, and techniques for written and oral presentation of research results. Research paper and oral presentation required.

Letter grade only (A-F). Same course as CHEM 466. Not open for credit to students with credit in BIOL 466H or CHEM 466H. (Lecture 3 hours).

### 467./567. Multivariate Data Analysis (4) F, odd years

Prerequisites: BIOL 260; MATH 119B or 123; 6 units of upper division biological science; all with a grade of "C" or better. (Undergraduates enroll in BIOL 467; graduates enroll in BIOL 567.)

Multivariate data analysis techniques applied to biological data. Applied matrix algebra for analyzing and understanding multivariate analysis. Includes principal components analysis, factor analysis,

discriminant analysis, cluster analysis and current modern phylogenetic analysis techniques. Analyzing multivariate biological data using computerized statistical packages.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.)

### **472./572. Molecular Evolution (3)**

Prerequisite: BIOL 370 with a grade of "C" or better.

Recommended: BIOL 312. (Undergraduates enroll in BIOL 472; graduates enroll in BIOL 572.)

Survey of molecular evolution including but not limited to the history of the field, protein and DNA evolution, neutral and nearly-neutral theory, molecular phylogenetics, molecular population genetics and DNA fingerprinting, genomics, and proteomics. Applicable to ecological, evolutionary, medical, forensic sciences.

Letter grade only (A-F). (Lecture 3 hrs.)

### **473./573. Molecular Genetics (3) S**

Prerequisites: BIOL 370 or MICR 371; CHEM 320A,B or 322A,B and 323A,B, or 327, all with a grade of "C" or better. (Undergraduates enroll in BIOL 473; graduates enroll in BIOL 573.)

Contemporary molecular genetic analysis of model organisms (mouse, worm, flies, yeasts) used in study of human disease, basic biological processes, gene regulation, and global analysis of genomes and proteomes.

Letter grade only (A-F). (Lecture 3 hrs.)

### **477./577. Biotechnology: Applications of Molecular Techniques and Bioinformatics (4) F**

Prerequisite: BIOL 340 or 370 or CHEM 441A,B; all with a grade of "C" or better. (Undergraduates enroll in BIOL 477; graduates enroll in BIOL 577.)

Theory and techniques for isolating, amplifying, and analyzing genes, genomes, transcripts, and proteins. Data-mining, the use of computers in experimental design and/or functional analysis, use of microarrays, and future of nanotechnology.

Letter grade only (A-F). Same course as MICR 477./577. Not open for credit to students with credit in MICR 477./577. (Lecture 3 hrs., activity 2 hrs.)

### **480./580. Seminars (1) F,S**

Prerequisites: Consent of undergraduate [graduate] advisor. (Undergraduates and classified post-baccalaureates enroll in BIOL 480; graduates enroll in BIOL 580). Undergraduates must have filed for graduation and be in their last semester. Graduates must have been admitted to the department as a graduate student. Classified post-baccalaureates must have been admitted to a second baccalaureate or a certificate.

Weekly meetings with professional biologists presenting results of their research. Requires participation in organization and critical evaluation of these presentations.

(Seminar 1 hr.) Letter grade only (A-F). May not be repeated for credit towards any single degree.

### **490./590. Selected Topics in Biology (1-3)**

Prerequisites: BIOL 211, 212, 213 all with a grade of "C" or better, and consent of instructor. (Undergraduates enroll in BIOL 490; graduates enroll in BIOL 590.)

Topics from selected areas of biology. Course content varies from section to section.

Letter grade only (A-F). May be repeated to a maximum of 6 units with different topics. Topics announced in the *Schedule of Classes*. (Lecture 1-3 hrs.)

### **490L./590L. Selected Topics in Biology, Laboratory (1-2)**

Prerequisites: BIOL 211, 212, 213 all with a grade of "C" or better, and consent of instructor. (Undergraduates enroll in BIOL 490L; graduates enroll in BIOL 590L.)

Topics from selected areas of biology. Course content varies from section to section.

Letter grade only (A-F). May be repeated to a maximum of 4 units with different topics. Topics announced in the *Schedule of Classes*. (Laboratory 3 or 6 hrs.)

### **492A./592A. Stem Cell Research Internship (12) F,S**

Prerequisites: BIOL 432/532, 432L/532L, 440L, 462/562, 473/573, 477/577, all with a grade of "C" or better, and permission of the director of the CSULB Biotechnology Certificate Program, and acceptance in the Stem Cell Training Option within the Biotechnology Certificate. (Undergraduates enroll in BIOL 492A; graduates enroll in BIOL 592A.)

CIRM-approved institutions train interns in their stem cell research laboratories.

Must be repeated once for credit. Credit/No Credit grading only. (Laboratory 36 hrs.)

### **495. Instruction in Laboratory Teaching (1-2) F,S**

Prerequisites: Consent of instructor, an "A" in the course in which the student elects to do MICR 495 (another course with laboratory may be substituted with consent of instructor), and an overall GPA of at least 3.0.

Individual instruction in organization and techniques of teaching a microbiology laboratory.

May be repeated to a maximum of 2 units in different semesters. Any units beyond the two taken for a letter grade in BIOL 495 or MICR 495 or any combination of the two will be taken credit/no credit. Same course as MICR 495. Not open for credit to students with credit in MICR 495. (Conference 1 hr., laboratory 3 hrs. per unit.)

### **496. Undergraduate Directed Research (1-3) F,S**

Prerequisites: BIOL 211, 212; either BIOL 213 or MICR 211 or BIOL 296 or MICR 296; consent of instructor; and consent of appropriate undergraduate advisor.

Research in a specific topic in biological sciences approved and directed by a faculty member in Department of Biological Sciences.

May be repeated for a letter grade and degree credit to a maximum of three units for any single degree or option. Units beyond the three taken for a letter grade in MICR 496 or BIOL 496, or any combination of the two, will be taken credit/no credit. Same course as MICR 496. Not open for credit to student with credit in MICR 496. Students may only have a total of 3 units of BIOL 496 and MICR 496 combined. Not available to graduate students.

### **498H. Senior Thesis – Honors (3)**

Prerequisites: BIOL 466; at least one unit of BIOL 496 with a grade of "A"; admission into the Honors in Biology program, and consent of instructor.

Planning, preparation, completion, and oral presentation of a written thesis based on a research project in biological sciences begun in BIOL/MICR 496. Not available to graduate students.

Letter grade only (A-F).

## **GRADUATE LEVEL**

### **511./411. Marine Mammalogy (3) S, odd years**

Prerequisite(s): BIOL 345, 350, and 353, all with grade of "C" or better, and consent of instructor. (Undergraduates enroll in BIOL 411; graduates enroll in BIOL 511.)

Fundamental biological, ecological, and physiological concepts of marine mammals, including cetaceans, pinnipeds, walrus, sirenians, and polar bears. Information concerning taxonomy, distribution, morphology, physiology, reproduction, and feeding through readings and scientific literature. Fieldtrips may include weekends and spring recess.

Letter grade only (A-F). (Lecture 2 hrs., lab and fieldtrips 3 hrs.)

### **512./412. Advanced Evolutionary Biology (3)**

Prerequisite: BIOL 312 with a grade of "C" or better. (Undergraduates enroll in BIOL 412; graduates enroll in BIOL 512.)

Advanced survey of topics in evolutionary biology including but not limited to population and quantitative genetics, allometry, game theory, evolutionary psychology, and evolutionary-developmental biology. Main emphasis on the development of conceptual and mathematical models of evolutionary processes.

Letter grade only (A-F). (Lecture 3 hrs.)

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## Biology Courses (BIOL)

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### 515./415. Marine Microbiology (3) F, odd years

Prerequisite: BIOL 353 or MICR 355 or BIOL 355 with a grade of "C" or better. (Undergraduates enroll in BIOL 415; graduates enroll in BIOL 515.)

Designed to familiarize microbiology and marine biology students with the role of microorganisms in the marine environment. Topics will include ecology, physiology, biogeochemistry and diversity of marine microbes. Laboratory/field component will emphasize examination and cultivation of local marine microbes.

Letter grade only (A-F). Course fee may be required. Same course as MICR 515. Not open for credit to students with credit in MICR 515. (Lecture 2 hrs., laboratory and field 3 hrs., weekend field trip may be required.)

### 516./416. Virology (3) F,S

Prerequisite: MICR 320 or BIOL 340 with a grade of "C" or better. (Undergraduates enroll in BIOL 416; graduates enroll in BIOL 516.)

Virology at molecular level including viral replication and molecular basis for viral pathogenesis; survey of human, animal, and plant viral diseases. Current trends for prevention and treatment of viral diseases.

Letter grade only (A-F). Same course as MICR 516. Not open for credit to students with credit in MICR 516. (Lecture 3 hrs.)

### 520./420. Fisheries Ecology and Conservation (3) F

Prerequisite(s): BIOL 260, 350, 353, and 419, all with grade of "C" or better. (Undergraduates enroll in BIOL 420; graduates enroll in BIOL 520.)

Advanced aspects of fish and invertebrate biology and behavior; fisheries economics and conservation; emphasis on state-of-art field/laboratory techniques and contemporary concepts and their application in fishery management.

Letter grade only (A-F). (Lecture 2 hrs., laboratory and field 3 hrs.)

### 524./424. Ornithology (3) S

Prerequisites: BIOL 211, 212, 213, 260 and 3 units of upper division BIOL, all with a grade of "C" or better. Recommended: BIOL 350. (Undergraduates enroll in BIOL 424; graduates enroll in BIOL 524.)

Ecology, morphology, physiology, behavior, and taxonomy of birds from an evolutionary perspective, also factors influencing recent increase in their extinction risk. Species identification techniques (emphasis on the local avifauna) and methods of surveying avian populations.

Letter grade only (A-F). (Lecture 2 hrs., laboratory/field 3 hrs.) Course fee may be required.

### 531./431. Biology of Cancer (3) F,S

Prerequisites: BIOL 340, 370 with a grade of "C" or better. (Undergraduates enroll in BIOL 431, graduates enroll in BIOL 531.)

An examination of cancer, tumor progression, and treatment at the cellular, molecular, and genetic levels.

Letter grade only (A-F). (Lecture 3 hrs.)

### 532./432. Stem Cell Biology (3) S

Prerequisites: BIOL 433 or 533 with a grade of "C" or better. (Undergraduates enroll in BIOL 432; graduates enroll in BIOL 532.)

Current literature on advances in stem cell research, translational research, and clinical applications of stem cells to alleviate human disease.

Letter grade only (A-F). (Lecture 3 hrs.)

### 532L./432L. Advanced Stem Cell Laboratory (4) SS

Prerequisites: BIOL 432/532, 440L, 462/562, 473/573, 477/577, all with a grade of "C" or better, and permission of the director of the CSULB Biotechnology Certificate Program. (Undergraduates enroll in BIOL 432L; graduates enroll in BIOL 532L.)

Intensive laboratory, offered during a 6-week summer session. Students learn basic and advanced stem cell culture techniques. The sixth week is 40 hours at the Children's Hospital of Orange County Research Institute (CHOC).

Letter grade only (A-F). (Lecture 1 hr., laboratory 9 hrs.)

### 533./433. Developmental Biology (3) F,S

Prerequisites: BIOL 340, and either BIOL 370 or MICR 371, both with a grade of "C" or better. (Undergraduates enroll in BIOL 433; graduates enroll in BIOL 533.)

Experimental approaches to development in model organisms, mostly animal, at the molecular, genetic, cellular, and tissue levels. Topics include gametogenesis, fertilization, early cleavage, gastrulation, pattern formation, and organogenesis.

Letter grade only (A-F). (Lecture/discussion 3 hrs.)

### 540. Advanced Molecular Cell Biology and Physiology (3) F

Prerequisites: Graduate standing and consent of instructor.

In depth discussion of cellular processes and their regulation and how they relate to organismal physiology. Includes critical reading and discussion of primary journal articles on pertinent topics.

Letter grade only (A-F). (Lecture 3 hrs.)

### 542./442. Physiology at the Limit (3)

Prerequisites: BIOL 342 or 345 with a grade of "C" or better. (Undergraduates enroll in BIOL 442; graduates enroll in BIOL 542.)

Survey of physiological adaptations of animals in conditions of extreme performance and environmental limitations. Topics include individual and evolutionary responses to high-altitude, deep-sea diving, outer space and micro-gravity, exercise, flight, swimming, and extreme temperatures. Examples from vertebrates and invertebrates.

Letter grade only (A-F). (Lecture 3 hrs.)

### 543./443. Endocrinology (3) F,S

Prerequisites: BIOL 340 or CHEM 441B; CHEM 320A or 322A or 327; and one of BIOL 341, 342, 345, 445, 448; CHEM 441A or 448, all with a grade of "C" or better. (Undergraduates enroll in BIOL 443; graduates enroll in BIOL 543.)

Role of endocrines in vertebrate and invertebrate adjustment to changes in internal and external environment.

Letter grade only (A-F). (Lecture 3 hrs.)

### 544./444. Reproductive Biology (3) S

Prerequisite: BIOL 342 or 345 with a grade of "C" or better. (Undergraduates enroll in BIOL 444; graduates enroll in BIOL 544.)

Topics in comparative reproductive biology from molecular, cellular, organismal, and population levels. Hormones and reproduction, gamete/gonad biology, reproductive lifespan, mating system/strategies, environmental influence on reproductive capabilities, contraception/*in vitro* fertilization. Scientific communication discussed including scientific articles and scientific writing.

Letter grade only (A-F). (Lecture 3 hrs.)

### 545./445. Metabolic Regulation (3) F

Prerequisites: BIOL 340, 342 or 345; CHEM 441A with grade of "C" or better. (Undergraduates enroll in BIOL 445; graduates enroll in BIOL 545.)

Study of molecular mechanisms by which intermediary metabolism is regulated in various mammalian tissues with emphasis on mechanisms of hormone action and regulation of some key enzymes of carbohydrate, fat, and protein metabolism.

Letter grade only (A-F). (Lecture 3 hrs.)

### 547./447. Molecular Plant Physiology (3) S

Prerequisites: BIOL 340, 370, both with grade of "C" or better. (Undergraduates enroll in BIOL 447; graduates enroll in BIOL 547.)

Molecular approaches to classical topics including plant hormones, photosynthesis, resistance to plant pathogens, adaptation of plants to environmental stress, and development of plants.

Letter grade only (A-F). (Lecture 3 hrs.)

### 548./448. Principles of Neurobiology (3) F,S

Prerequisites: BIOL 340 or CHEM 441B and one of BIOL 341, 342, or 345 all with a grade of "C" or better. (Undergraduates enroll in BIOL 448; graduates enroll in BIOL 548.)

Study of the principles of anatomy, physiology, and function of the nervous system. Topics covered include neuroanatomy, physiology

of neuronal signaling (excitable membranes and action potentials), synaptic transmission, neurotransmitters and their receptors, pain processing, special senses, reflexes, and neural circuits.

Letter grade only (A-F). (Lecture 3 hrs.)

### **549./449. Fish Physiology and Endocrinology (3)**

Prerequisite: BIOL 345 with a grade of "C" or better. (Undergraduates enroll in BIOL 449; graduates enroll in BIOL 549.)

Fundamentals of physiological systems and strategies in fishes, with emphasis on endocrine regulatory mechanisms. Adaptations in endocrine physiology of fishes considered from evolutionary and ecological perspectives. Impacts of human activities, particularly in context of Southern California's marine environment addressed.

Letter grade only (A-F). (Lecture 3 hrs.)

### **550./450. Plant Ecology (3) S, even years**

Prerequisites: BIOL 260, 350 both with a grade of "C" or better. Recommended: BIOL 427, 447. (Undergraduates enroll in BIOL 450; graduates enroll in BIOL 550.)

Relationship of plants to their environment and principles of plant distribution.

Letter grade only (A-F) (Lecture 2 hrs., laboratory and field 3 hrs.) Course fee may be required.

### **551./451. Wetlands and Mangrove Ecology (3) S, odd years**

Prerequisites: BIOL 260, 350 both with a grade of "C" or better. (Undergraduates enroll in BIOL 451; graduates enroll in BIOL 551.)

Comprehensive look at wetland ecology and management. Focuses on physical, biogeochemical, and ecological aspects of major wetland ecosystems with an emphasis on local urban wetlands. Includes wetland management concepts and approaches worldwide.

Letter grade only (A-F). (Lecture 2 hrs., laboratory and field 3 hrs.)

### **552./452. Behavioral Ecology (3)**

Prerequisites: BIOL 211, 212, 213, 260 all with a grade of "C" or better. Prerequisite/Corequisite: BIOL 312 or 350. (Undergraduates enroll in BIOL 452; graduates enroll in BIOL 552.)

Primary objectives are to understand how animal behavior affects survival and reproduction and introduce students to current methodologies to study behavior of animals in lab and field conditions. Emphasizes ecological and evolutionary consequences of behavior across taxa.

Letter grade only (A-F). (Lecture 2 hrs., laboratory/field 3 hrs.)

### **553./453. Insect Ecology (3) F, even years**

Prerequisites: BIOL 350 with a grade of "C" or better. (Undergraduates enroll in BIOL 453; graduates enroll in BIOL 553.)

Field and experimental studies of abundance, dispersal, distribution, and behavior of insects.

Letter grade only (A-F). (Lecture 2 hrs., laboratory and field 3 hrs.)

### **554A./454A. Research in Tropical Marine Ecology (3) S, even years**

Prerequisite(s): BIOL 350, 353, and one of BIOL 313 or 419 or 425, all with grade of "C" or better, and consent of instructor. (Undergraduates enroll in BIOL 454A; graduates enroll in BIOL 554A.)

Field and laboratory studies, lectures, and individual research on tropical marine biological problems. Designed to engage students in experimental research, including: recognizing a problem, designing and carrying out a project, statistical data analysis, and oral and written report presentation.

Eight-day field trip to Hawaii required during spring recess at student expense. Enrollment is limited. Letter grade only (A-F). Course fee may be required. (Lecture 2 hrs., 8 day field trip.)

### **554B./454B. Research in Tropical Terrestrial Ecology (3) S, odd years**

Prerequisites: BIOL 350; one of BIOL 316, 324, 421, 424, 427, or 439, all with a grade of "C" or better, and consent of instructor.

(Undergraduates enroll in BIOL 454B; graduates enroll in BIOL 554B.)

Field-based comparison of tropical lowland deciduous forest and lowland rainforest incorporating basic ecology methodology. Forest structure and diversity of animals emphasized. Students maintain field notebook, submit final paper, and give oral presentation.

Nine-day fieldtrip to Costa Rica required during spring recess at student expense. Enrollment is limited. Letter grade only (A-F). Course fee may be required. (Lecture 2 hr., 9 day field trip.)

### **555./455. Ecology of Marine Communities (3) F, even years**

Prerequisites: BIOL 260, 350, 353 all with a grade of "C" or better. (Undergraduates enroll in BIOL 455; graduates enroll in BIOL 555.)

Field studies on ecological principles related to marine communities discussed. Includes individual field research project and two class projects.

Letter grade only (A-F). (Lecture 2 hrs., field 3 hrs.)

### **556./456. Population Ecology (3)**

Prerequisites: BIOL 350; MATH 119B or 123; all with a grade of "C" or better. (Undergraduates enroll in BIOL 456; graduates enroll in BIOL 556.)

Analysis of animal and plant populations characteristics: population growth and regulation, fluctuation and regulation, competition, predation, parasitism, and other intraspecific and interspecific interactions; spatial patterns.

Letter grade only (A-F). (Lecture 3 hrs.)

### **557./457. Field Methods in Ecology (3)**

Prerequisites: BIOL 260, 350 both with a grade of "C" or better. (Undergraduates enroll in BIOL 457; graduates enroll in BIOL 557.)

Design of field research projects, collection, and data analysis, report writings and presentations. Field sampling techniques emphasized. Five weekend fieldtrips required.

Letter grade only (A-F). (Lecture 2 hrs., laboratory and field 3 hrs.)

### **559./459. Conservation Biology (3) F**

Prerequisite: BIOL 260, 350 both with a grade of "C" or better. Recommended: BIOL 370. (Undergraduates enroll in BIOL 459; graduates enroll in BIOL 559.)

Conservation biology concepts including population dynamics, extinction processes, population viability analyses, metapopulations, community-level interactions, island biogeography, biological diversity patterns, habitat fragmentation, reserve design, and landscape-level conservation. Lecture includes group discussions of case studies and relevant primary literature.

Letter grade only (A-F). (Lecture 3 hrs.) 20 hrs. per semester service learning for undergraduates, extra research paper for graduates.

### **562./462. Bioethics and Public Policy (3) S**

Prerequisites: BIOL 340 with a grade of "C" or better. (Undergraduates enroll in BIOL 462; graduates enroll in BIOL 562.)

History of bioethics, scientific and medical bases of key bioethical issues, current legislation and appropriations, including legal, social, and ethical implications of stem cell research and other biotechnological advances.

Letter grade only (A-F). (Lecture 3 hrs.)

### **563./463. Computer Modelling in Biology (4)**

Prerequisites: BIOL 260, 350 both with a grade of "C" or better. (Undergraduates enroll in BIOL 463; graduates enroll in BIOL 563.)

History, modeling theory, different modeling approaches, theoretical, empirical and quantitative modeling. Laboratory uses modeling software and focuses on model construction and quantitative simulation. Applicable to ecology, microbiology, physiology, environmental sciences, etc.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.) Course fee may be required.



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## Biology Courses (BIOL)

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### 564./464. Aquatic Toxicology (3)

Prerequisites: BIOL 211, 212, 213, 340; CHEM 320A or 322A or 327, all with a grade of "C" or better. Recommended: BIOL 353 and CHEM 448 or 441A,B. (Undergraduates enroll in BIOL 464; graduates enroll in BIOL 564.)

In depth study of interactions between anthropogenic chemicals and aquatic ecosystems, including origin, fate, chemical and biological detection, and quantification of pollutants and impact at molecular, biochemical, cellular, physiological, organismal, and community levels of organization. Individual research project required.

Letter grade only (A-F). (Lecture 3 hrs.)

### 565./465. Experimental Design and Regression Analysis (4) F, even years

Prerequisites: BIOL 260; MATH 119B or 123; 6 units of upper division biological science all with a grade of "C" or better. (Undergraduates enroll in BIOL 465; graduates enroll in BIOL 565.)

Experimental design and data analysis techniques applied to problems in biology including analysis of variance and covariance, bivariate and multiple regression, experimental design, bootstrapping and randomization tests, and nonparametric statistics. Experience in analyzing biological data using computerized statistical packages.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.)

### 567./467. Multivariate Data Analysis (4) F, odd years

Prerequisites: BIOL 260; MATH 119B or 123; 6 units of upper division biological science all with a grade of "C" or better. (Undergraduates enroll in BIOL 467; graduates enroll in BIOL 567.)

Multivariate data analysis techniques applied to biological data. Applied matrix algebra for analyzing and understanding multivariate analysis. Includes principal components analysis, factor analysis, discriminant analysis, cluster analysis and current modern phylogenetic analysis techniques. Analyzing multivariate biological data using computerized statistical packages.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.)

### 570. Advanced Genetics (3) S

Prerequisites: Graduate standing and consent of instructor.

In depth discussion of various advanced topics in genetics, which may include population genetics, molecular phylogeny, and microbial genetics. Includes critical reading and discussion of primary journal articles on pertinent topics.

Letter grade only (A-F). (Lecture 3 hrs.)

### 572./472. Molecular Evolution (3)

Prerequisite: BIOL 370 with a grade of "C" or better. Recommended: BIOL 312. (Undergraduates enroll in BIOL 472; graduates enroll in BIOL 572.)

Survey of molecular evolution including but not limited to the history of the field, protein and DNA evolution, neutral and nearly-neutral theory, molecular phylogenetics, molecular population genetics and DNA fingerprinting, genomics, and proteomics. Applicable to ecological, evolutionary, medical, forensic sciences.

Letter grade only (A-F). (Lecture 3 hrs.)

### 573./473. Molecular Genetics (3) S

Prerequisites: BIOL 370 or MICR 371; CHEM 320A,B or 322A,B and 323A,B, or 327, all with a grade of "C" or better. (Undergraduates enroll in BIOL 473; graduates enroll in BIOL 573.)

Contemporary molecular genetic analysis of model organisms (mouse, worm, flies, yeasts) used in study of human disease, basic biological processes, gene regulation, and global analysis of genomes and proteomes.

Letter grade only (A-F). (Lecture 3 hrs.)

### 577./477. Biotechnology: Applications of Molecular Techniques and Bioinformatics (4) F

Prerequisite: BIOL 340 or 370 or CHEM 441A,B; all with a grade of "C" or better. (Undergraduates enroll in BIOL 477; graduates enroll in BIOL 577.)

Theory and techniques for isolating, amplifying, and analyzing genes, genomes, transcripts, and proteins. Data-mining, the use of computers in experimental design and/or functional analysis, use of microarrays, and future of nanotechnology.

Letter grade only (A-F). Same course as MICR 577/477. Not open for credit to student with credit in MICR 577/477. (Lecture 3 hrs., activity 2 hrs.)

### 580./480. Seminars (1) F,S

Prerequisites: Consent of undergraduate [graduate] advisor. (Undergraduates and classified post-baccalaureates enroll in BIOL 480; graduates enroll in BIOL 580). Undergraduates must have filed for graduation and be in their last semester. Graduates must have been admitted to the department as a graduate student. Classified post-baccalaureates must have been admitted to a second baccalaureate or a certificate.

Weekly meetings with professional biologists presenting results of their research. Requires participation in organization and critical evaluation of these presentations.

(Seminar 1 hr.) Letter grade only (A-F). May not be repeated for credit towards any single degree.

### 590./490. Selected Topics in Biology (1-3)

Prerequisites: BIOL 211, 212, 213 all with a grade of "C" or better, and consent of instructor. (Undergraduates enroll in BIOL 490; graduates enroll in BIOL 590.)

Topics from selected areas of biology. Course content varies from section to section.

Letter grade only (A-F). May be repeated to a maximum of 6 units with different topics. Topics announced in the *Schedule of Classes*. (Lecture 1-3 hrs.)

### 590L./490L. Selected Topics in Biology, Laboratory (1-2)

Prerequisites: BIOL 211, 212, 213 all with a grade of "C" or better, and consent of instructor. (Undergraduates enroll in BIOL 490L; graduates enroll in BIOL 590L.)

Topics from selected areas of biology. Course content varies from section to section.

Letter grade only (A-F). May be repeated to a maximum of 4 units with different topics. Topics announced in the *Schedule of Classes*. (Laboratory 3 or 6 hrs.)

### 592A./492A. Stem Cell Research Internship (12) F,S

Prerequisites: BIOL 432/532, 432L/532L, 440L, 462/562, 473/573, 477/577, all with a grade of "C" or better, and consent of the director of the CSULB Biotechnology Certificate Program, and acceptance in the Stem Cell Training Option within the Biotechnology Certificate. (Undergraduates enroll in BIOL 492A; graduates enroll in BIOL 592A.)

CIRM-approved institutions train interns in their stem cell research laboratories. Must be repeated once for credit.

Credit/No Credit grading only. (Laboratory 36 hrs.)

### 663. Seminar in Cell and Molecular Biology (2)

Critical evaluation of field's primary literature, including oral and/or written presentation of critiques.

May be repeated to a maximum of 4 units with different topics. Letter grade only (A-F) (Seminar 2 hrs.)

### 664. Seminar in Marine Biology (2)

Critical evaluation of field's primary literature, including oral and/or written presentation of critiques.

May be repeated to a maximum of 4 units with different topics. Letter grade only (A-F) (Seminar 2 hrs.)

### 665. Seminar in Ecology (2)

Critical evaluation of field's primary literature, including oral and/or written presentation of critiques.

May be repeated to a maximum of 4 units with different topics. Letter grade only (A-F) (Seminar 2 hrs.)

### **666. Seminar in Physiology (2)**

Critical evaluation of field's primary literature, including oral and/or written presentation of critiques.

May be repeated to a maximum of 4 units with different topics. Letter grade only (A-F) (Seminar 2 hrs.)

### **696A. Research Design (2)**

Prerequisites: Graduate standing in the Department of Biological Sciences and departmental permission.

Research design, statistics, literature searches, and thesis proposal writing, utilizing tools to initiate research projects. Laboratory utilizes computers for literature searches, sample size determination, data processing, statistical analyses, and bioinformatics. Required for all first/second semester graduate students.

Letter grade only (A-F). (Lecture 1 hr., laboratory 3 hrs.)

### **696B. Scientific Communication (2)**

Prerequisite: BIOL 696A with a grade of "B" or better.

Presentation/publication skills for communicating biological research to professional and lay audiences: scientific writing, data presentation (posters and oral).

Letter grade only (A-F). (Lecture 1 hr., laboratory 3 hrs.) Course fee may be required.

### **697. Directed Research (1-3) F,S**

Prerequisite: Consent of instructor.

Research on specific topic approved and directed by a faculty member in the biological sciences. Written report required.

May be repeated for a letter grade and degree credit to a maximum of three units. Any units beyond the three taken for a letter grade in BIOL 697 or MICR 697 or any combination of the two must be taken credit/no credit.

### **698. Thesis (1-6) F,S**

Prerequisites: Advancement to Candidacy for the Master of Science in Biology, and consent of the chair of the thesis committee and the departmental graduate advisor.

Planning, preparation, writing, defense, oral presentation, and completion of a research thesis in the biological sciences.

Letter grade only (A-F).

Students pursuing a major and/or a minor in this department may receive unit credit for courses marked with the symbol '##' as a general elective but may not apply the units toward the specific or elective requirements for any degree or option in this department. Majors in this Department may, however, take, for general education purposes, interdisciplinary courses offered by this department. All other courses in this department are open to majors and minors but by letter grade only.

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## **Microbiology Courses (MICR)**

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### **LOWER DIVISION**

#### **101. ## Introduction to Human Disease (3) F, S**

Prerequisite/Corequisite: Course that fulfills the A.1 GE requirement.

Introduction to the study of human disease including moral/ethical and economic issues.

(Lecture 3 hrs.)

#### **200. General Microbiology for Health Professionals (4) F, S**

Prerequisites: CHEM 111A or 140 with a grade of "C" or better and GE Foundation requirements.

Microbiology for those planning careers in nursing, health care and education, and foods and nutrition. Introduction to microorganisms, including structure, function, metabolism, growth, genetics, diversity, and applied aspects. Special emphasis on human health.

Not open for credit to majors in the biological sciences. (Lecture 2 hrs., laboratory 6 hrs.) Course fee may be required.

#### **211. General Microbiology (5) F,S**

Prerequisites: BIOL 211, 212; CHEM 111B, all with a grade of "C" or better.

Introduction to biology of microorganisms, including structure, function, metabolism, growth, genetics, diversity, host-parasite relationships, and applied aspects.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 6 hrs.) Course fee may be required.

#### **296. Introduction to Undergraduate Directed Research (1) F,S**

Prerequisites: Consent of instructor.

Introduction to research in microbiology approved and directed by a faculty member in the Department of Biological Sciences. Designed primarily to introduce lower division students to research before taking MICR/BIOL 496.

May be repeated to a maximum of 3 units in different semesters. Students who have completed one or more units of MICR/BIOL 496 may not enroll in this course. Credit/No Credit grading only. (Conference 1 hr., laboratory 3 hrs.) Same course as BIOL 296.

### **UPPER DIVISION**

#### **300I. ## Human Immunology: In Self-Defense (3) F**

Prerequisites: GE Foundation requirements, one or more Explorations courses, and upper-division standing; one laboratory course in a life science. Introductory psychology and a laboratory course in a physical science recommended.

Mechanisms and cells responsible for protecting human body from disease. Normal functions of immune system, diseases involving immune system, and psychological, endocrine and age factors affecting immune system included. Impact of immunology or organ transplantation, immunotherapy, and biotechnology discussed.

Not applicable for credit toward the major in Microbiology. (Lecture 3 hrs.)

#### **320. Bacterial Pathogenesis (3) F,S**

Prerequisite: MICR 211 with a grade of "C" or better.

Nature of host-pathogen interactions in health and disease. Emphasis upon pathogenic bacteria of humans and animals; topics include bacterial ultrastructure, epidemiology, and mechanisms of pathogenesis, host defense mechanisms, and antibiotic therapy.

Letter grade only (A-F). Course fee may be required. (Lecture 3 hrs.)

#### **320L. Bacterial Pathogenesis Laboratory (2) F,S**

Prerequisite or corequisite: MICR 320 with a grade of "C" or better.

Experiments using modern and classical techniques for the isolation, identification, and characterization of pathogenic bacteria. Molecular mechanisms of bacterial virulence are emphasized. Techniques used include PCR, SDS-PAGE, serotyping, and immunofluorescence microscopy.

Letter grade only (A-F). (Laboratory 6 hrs.)

#### **322. Mycology/Parasitology (5) F,S**

Prerequisites: BIOL 211, 212; MICR 320, all with a grade of "C" or better.

Second of a two-semester sequence (MICR 320/322) in medical microbiology for majors. Survey of parasitic protozoa, helminthes, and fungi of humans; emphasis on identification of fresh and preserved specimens, pathogenesis, host-parasite interactions, epidemiology, prevention, and control.

Letter grade only (A-F). (Lecture 3 hrs., laboratory 6 hrs.) Course fee may be required.

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## Microbiology Courses (MICR)

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### 325. Emerging Infectious Diseases (3)

Prerequisites: MICR 211 with a grade of "C" or better and consent of instructor.

Explores changes in technology, infectious disease organisms and other factors contributing to emerging and re-emerging infectious diseases, including immunodeficiency, antibiotic and insecticide abuses, climate change, travel and commerce, human demographic and behavioral changes, land use, and breakdown of public health.

Letter grade only (A-F). (Lecture 3 hrs.)

### 355. Microbial Ecology (3) S

Prerequisites: MICR 211 or BIOL 211, 212, 213 all with a grade of "C" or better.

Explores relationships of microorganisms to their environment. Emphasis placed on ecological basis for diversity of prokaryotic forms, metabolic functions and community interactions.

Letter grade only (A-F). Same course as BIOL 355. Not open for credit to students with credit in BIOL 355. (Lecture 3 hrs.)

### 355L. Microbial Ecology Laboratory (1) S

Prerequisite/Corequisite: BIOL 355 or MICR 355.

Provides an understanding of microbes in the environment. Sample and analyze microbes from field trips to different habitats. Analytical techniques learned include enrichment culture methods and modern molecular biology methods to study the diversity and community dynamics of microbes.

Letter grade only (A-F). Course fee may be required. Same course as BIOL 355L. Not open for credit to students with credit in BIOL 355L. (Laboratory 3 hrs.)

### 371. Microbial Genetics (3) F

Prerequisite: MICR 211 with a grade of "C" or better.

Genetic analysis of biological processes in microbes. Includes gene structure, regulation, and function; isolation/analysis of mutations in haploid/diploid organisms; gene function from mutants; genetic exchange; regulation of host-pathogen interactions; bacteriophages; cloned genes; and genomics.

Letter grade only (A-F). (Lecture 3 hrs.)

### 372. Methods in Microbial Genetics (2) F

Prerequisite: MICR 211 with a grade of "C" or better. Recommended: MICR 371.

Laboratory study of microbial genetics, using classical (non-molecular) and contemporary (molecular) approaches. Includes genetic engineering techniques; microbial genomics.

Not open for credit to students with credit in MICR 451. Letter grade only (A-F). (Laboratory 6 hrs.) Course fee may be required.

### 415./515. Marine Microbiology (3) F, odd years

Prerequisite: MICR 355 or BIOL 355 or BIOL 353 with a grade of "C" or better. (Undergraduates enroll in MICR 415; graduates enroll in MICR 515.)

Designed to familiarize microbiology and marine biology students with the role of microorganisms in the marine environment. Topics will include ecology, physiology, biogeochemistry, and diversity of marine microbes. Laboratory/field component will emphasize examination and cultivation of local marine microbes.

Letter grade only (A-F). Course fee may be required. Same course as BIOL 415. Not open for credit to students with credit in BIOL 415. (Lecture 2 hrs., laboratory and field 3 hrs., weekend field trip may be required.)

### 416./516. Virology (3) F,S

Prerequisite: MICR 320 or BIOL 340 with a grade of "C" or better. (Undergraduates enroll in MICR 416; graduates enroll in MICR 516.)

Virology at molecular level including viral replication and molecular basis for viral pathogenesis; survey of human, animal, and plant viral diseases. Current trends for prevention and treatment of viral diseases.

Letter grade only (A-F). Same course as BIOL 416. Not open for credit to students with credit in BIOL 416. (Lecture 3 hrs.)

### 423./523. Hematology (4) F

Prerequisite: BIOL 340 with a grade of "C" or better. (Undergraduates enroll in MICR 423; graduates enroll in MICR 523.)

Study of blood and coagulation system. Normal cell structure and function and physiological and morphological changes in inflammation, leukemias, and anemias discussed. Clinical, diagnostic, and research techniques for observing blood and pathologic case-studies included.

Useful for student interested in medical professions. Required for clinical laboratory science (medical technology) internship. Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.) Course fee may be required.

### 429./529. Epidemiology of Infectious Diseases (3)

Prerequisites: BIOL 260; MICR 320, 322; all of a grade of "C" or better. (Undergraduates enroll in MICR 429; graduates enroll in MICR 529.)

Principles of epidemiology and application to health; fundamentals of biomedical statistics; basic factors in classic epidemiological studies and prevention and control of infectious diseases.

Letter grade only (A-F). (Lecture 3 hrs.)

### 430. Immunology (3) F,S

Prerequisite: BIOL 340 with a grade of "C" or better.

Study of cellular and molecular components of immune system, including how immune system recognizes pathogens, how it functions in various types of immune responses, mechanisms of vaccines, immunodeficiencies, transplantation, allergy, and autoimmunity.

Letter grade only (A-F). Same course as BIOL 430. Not open for credit to students with credit in BIOL 430. (Lecture 3 hrs.)

### 430L. Immunology Laboratory (2)

Prerequisite: BIOL 340 with a grade of "C" or better. Prerequisite/Corequisite: MICR 430.

Modern and classical techniques in cellular and molecular immunology. Experimental techniques have broader applications to other fields and include mammalian cell culture, antibody purification, SDS-PAGE, western blots, and assays of apoptosis, cell proliferation, cellular activation, and antibody-antigen interactions.

Letter grade only (A-F). (Laboratory 6 hrs.) Course fee may be required.

### 471./571. Bacterial Physiology (3) S

Prerequisites: MICR 320, CHEM 441A; both with a grade of "C" or better. (Undergraduates enroll in MICR 471; graduates enroll in MICR 571.)

Cellular physiology at molecular level as related to bacterial growth, reproduction, nutrition, metabolism, and ecology.

Letter grade only (A-F). (Lecture 3 hrs.)

### 473. Food and Industrial Microbiology (3) F

Prerequisites: MICR 200 or 211; CHEM 441A or 448; both with a grade of "C" or better.

Role of microorganisms in food and other industrial processes; emphasis on bacteria, yeasts and molds.

Letter grade only (A-F). (Lecture 2 hrs., laboratory 3 hrs.) Course fee may be required.

### 477./577. Biotechnology: Applications of Molecular Techniques and Bioinformatics (4) F

Prerequisite: BIOL 340 or 370 or CHEM 441A,B; all with a grade of "C" or better. (Undergraduates enroll in MICR 477; graduates enroll in MICR 577.)

Theory and techniques for isolating, amplifying, and analyzing genes, genomes, transcripts, and proteins. Data-mining, the use of computers in experimental design and/or functional analysis, use of microarrays, and future of nanotechnology.

Letter grade only (A-F). (Lecture 3 hrs., activity 2 hrs.)

### **490./590. Selected Topics in Microbiology (1-3)**

Prerequisites: MICR 211 with grade of "C" or better, and consent of instructor. (Undergraduates enroll in MICR 490; graduates enroll in MICR 590.)

Topics from selected areas of microbiology.

Letter grade only (A-F). May be repeated to a maximum of 6 units with different topics. Topics announced in the *Schedule of Classes*. (Lecture 1-3 hrs.)

### **495. Instruction in Laboratory Teaching (1-2) F,S**

Prerequisites: Consent of instructor, an "A" in the course in which the student elects to do MICR 495 (another course with laboratory may be substituted with consent of instructor), and an overall GPA of at least 3.0.

Individual instruction in organization and techniques of teaching a microbiology laboratory.

May be repeated to a maximum of 2 units in different semesters. Any units beyond the two taken for a letter grade in BIOL 495 or MICR 495 or any combination of the two will be taken credit/no credit. Same course as BIOL 495. Not open for credit to students with credit in BIOL 495. (Conference 1 hr., laboratory 3 hrs. per unit.)

### **496. Undergraduate Directed Research (1-3) F,S**

Prerequisites: BIOL 211, 212; either BIOL 213 or MICR 211 or BIOL 296 or MICR 296; consent of instructor; and consent of appropriate undergraduate advisor.

Research in a specific topic in biological sciences approved and directed by a faculty member in Department of Biological Sciences.

May be repeated for a letter grade and degree credit to a maximum of three units for any single degree or option. Units beyond the three taken for a letter grade in MICR 496 or BIOL 496, or any combination of the two, will be taken credit/no credit. Same course as BIOL 496. Not open for credit to student with credit in BIOL 496. Students may only have a total of 3 units of BIOL 496 and MICR 496 combined. Not available to graduate students.

## **GRADUATE LEVEL**

### **515./415. Marine Microbiology (3) F, odd years**

Prerequisite: MICR 355 or BIOL 355 or BIOL 353 with a grade of "C" or better. (Undergraduates enroll in MICR 415; graduates enroll in MICR 515.)

Designed to familiarize microbiology and marine biology students with the role of microorganisms in the marine environment. Topics will include ecology, physiology, biogeochemistry, and diversity of marine microbes. Laboratory/field component will emphasize examination and cultivation of local marine microbes.

Letter grade only (A-F). Course fee may be required. Same course as BIOL 515. Not open for credit to student with credit in BIOL 515. (Lecture 2 hrs., laboratory and field 3 hrs., weekend field trip may be required.)

### **516./416. Virology (3) F,S**

Prerequisite: MICR 320 or BIOL 340 with a grade of "C" or better. (Undergraduates enroll in MICR 416; graduates enroll in MICR 516.)

Virology at molecular level including viral replication and molecular basis for viral pathogenesis; survey of human, animal, and plant viral diseases. Current trends for prevention and treatment of viral diseases.

Letter grade only (A-F). Same course as BIOL 516. Not open for credit to students with credit in BIOL 516. (Lecture 3 hrs.)

### **523./423. Hematology (4) F**

Prerequisite: BIOL 340 with a grade of "C" or better. (Undergraduates enroll in MICR 423; graduates enroll in MICR 523.)

Study of blood and coagulation system. Normal cell structure and function and physiological and morphological changes in inflammation, leukemias, and anemias discussed. Clinical, diagnostic, and research techniques for observing blood and pathologic case-studies included.

Useful for student interested in medical professions. Required for clinical laboratory science (medical technology) internship. Letter grade only (A-F). (Lecture 3 hrs., laboratory 3 hrs.)

### **529./429. Epidemiology of Infectious Diseases (3)**

Prerequisites: BIOL 260; MICR 320, 322; all of a grade of "C" or better. (Undergraduates enroll in MICR 429; graduates enroll in MICR 529.)

Principles of epidemiology and application to health; fundamentals of biomedical statistics; basic factors in classic epidemiological studies and prevention and control of infectious diseases.

Letter grade only (A-F). (Lecture 3 hrs.)

### **571./471. Bacterial Physiology (3)**

Prerequisites: MICR 320, CHEM 441A,B; both with a grade of "C" or better. (Undergraduates enroll in MICR 471; graduates enroll in MICR 571.)

Cellular physiology at molecular level as related to bacterial growth, reproduction, nutrition, metabolism, and ecology.

Letter grade only (A-F). (Lecture 3 hrs.)

### **577./477. Biotechnology: Applications of Molecular Techniques and Bioinformatics (4) F**

Prerequisite: BIOL 340 or 370 or CHEM 441A,B; all with a grade of "C" or better. (Undergraduates enroll in MICR 477; graduates enroll in MICR 577.)

Theory and techniques for isolating, amplifying, and analyzing genes, genomes, transcripts, and proteins. Data-mining, the use of computers in experimental design and/or functional analysis, use of microarrays, and future of nanotechnology.

Letter grade only (A-F). Same course as BIOL 577. Not open for credit to students with credit in BIOL 577. (Lecture 3 hrs., activity 2 hrs.)

### **590./490. Selected Topics in Microbiology (1-3)**

Prerequisites: MICR 211 with grade of "C" or better, and consent of instructor. (Undergraduates enroll in MICR 490; graduates enroll in MICR 590.)

Topics from selected areas of microbiology.

Letter grade only (A-F). May be repeated to a maximum of 6 units with different topics. Topics announced in the *Schedule of Classes*. (Lecture 1-3 hrs.)

### **661. Seminar in Microbiology (2)**

Prerequisite: Consent of instructor.

Critical evaluation of literature in this field, including oral and/or written presentation of critiques.

May be repeated to a maximum of 4 units with different topics. Letter grade only (A-F). (Seminar 2 hours)

### **697. Directed Research (1-3) F,S**

Prerequisite: Consent of instructor.

Research on specific topic approved and directed by faculty member in the biological sciences. Written report required.

May be repeated for a letter grade and degree credit to a maximum of 3 units. Any units beyond the 3 units taken for a letter grade in BIOL 697 or MICR 697 or any combination of the two must be taken credit/no credit.

### **698. Thesis (1-6) F,S**

Prerequisites: Advancement to Candidacy for the Master of Science in Microbiology, consent of the chair of the thesis committee and the departmental graduate advisor.

Planning, preparation, writing, defense, oral presentation, and completion of a research thesis in the biological sciences.

Letter grade only (A-F).