

# BIOLOGICAL SCIENCES

Fisher Science Hall (33), Room 281

Phone: 805.756.2788

Email: biosci@calpoly.edu

<https://bio.calpoly.edu> (<https://bio.calpoly.edu/>)

Department Chair: Ken Hillers

## Academic Programs

Program name	Program type
Biological Sciences	BS, MS
Biology	Minor
Cross Disciplinary Studies Minor in Bioinformatics	Minor
Marine Sciences	BS
Microbiology	BS, Minor

The Biological Sciences Department offers undergraduate programs leading to Bachelor of Science degrees in Biological Sciences, Marine Sciences and Microbiology, and minors in Biology, Bioinformatics, and Microbiology. The graduate program leads to a Master of Science degree in Biology. In addition, courses are offered to satisfy life science requirements of academic majors across campus. The Biological Sciences Department is committed to serving the needs of a student population with diverse backgrounds and goals.

The Biological Sciences Department teaches courses with the following prefixes: BIO (Biology), BOT (Botany), MCRO (Microbiology), and MSCI (Marine Science).

The Biological Sciences Department encourages learning by doing in the classroom and through research, in the laboratory and the field. Most courses are accompanied by labs where students gain hands-on experience with biology. Cal Poly's geographical setting on the Central Coast of California offers unique opportunities for studying terrestrial, aquatic, and marine ecosystems. The Department offers a wide range of potential research experiences for our majors. Our faculty maintain active research laboratories where students can participate in the scientific process from start to finish, including presenting and publishing their work. Special opportunities are available through the Center for Applications in Biotechnology (CAB), which is developing biological tools to address environmental concerns through collaborative interdisciplinary research and education; the Center for Coastal Marine Science (CCMS), which promotes and facilitates basic and applied studies of coastal marine systems; and the Undergraduate Biotechnology Laboratory (UBL), which provides undergraduates with hands-on biotechnology experience. Additional resources for research and teaching include a 3000-ft pier at nearby Avila Bay, and natural history collections consisting of tens of thousands of insects, plants, birds, mammals, reptiles, amphibians, and fish.

Successful graduates enter careers in basic and applied research, public health, biotechnology, teaching, wildlife and natural areas conservation, consulting, and government agencies. Graduates are also well prepared to enter graduate or professional schools for advanced study of medicine, dentistry, veterinary science and other health sciences, as well as biodiversity, botany, climate change biology, conservation, ecology, evolution, genetics, genomics, marine sciences, microbiology, molecular biology, physiology, and zoology. The department offers courses required for pre-professional training in medicine and paramedical fields.

The department supports the concept of international education and encourages students to investigate opportunities for overseas study. For further information, see Cal Poly International Center (<https://international.calpoly.edu/>).

## Undergraduate Programs BS Biological Sciences

The degree offers students a broad education in biology from molecules to ecosystems, with an emphasis on hands-on training in the laboratory and the field. Biology majors can gain preprofessional preparation in the biomedical fields, coursework toward a teaching credential, progress toward professional certification, and/or preparation for graduate training in a field of interest. In addition to the core coursework for the biology major, students may choose a concentration in order to gain a deep, focused understanding of a specific subfield within biology, or may follow the general curriculum in biology for broader exposure to a variety of topics. Students are encouraged to consult with a faculty advisor and the College of Science and Mathematics Advising Center to help them learn about their chosen degree program, concentration choices, career options, study skills, and departmental opportunities. Students interested in teaching may choose any concentration and should contact the single subject credential advisor for information about teaching opportunities and recommended coursework. Students may not double major in Biological Sciences and Microbiology. Students may not double major in Biological Sciences and Marine Science.

### Concentrations

#### Anatomy and Physiology

Students in this concentration study biological sciences with an emphasis on the structure and function of humans and other animals. This concentration is ideal for students preparing for careers in the health professions.

#### Ecology, Evolution, Biodiversity, and Conservation

This concentration will prepare students to study the ecology and evolution of the earth's biodiversity and to participate in its conservation. The concentration will provide students with the skills necessary to participate in the conservation of wildlife, plants, and other wild species and their habitats. Professions in this arena include basic and applied research with state and federal resource management agencies, non-governmental organizations (N.G.O.s), and private consulting firms. These professions require a solid foundation in the identification of organisms, the principles of ecology and evolution, and the tools, policies and social context of conservation. This area of concentration is recommended for students seeking professional certification by off-campus entities such as The Wildlife Society and the Ecological Society of America; students interested in such certification programs should consult with their faculty advisor for specific programmatic guidance.

#### Molecular and Cellular Biology

Designed for students who are interested in how genes and their products work to create and maintain cells, tissues and organisms. This concentration augments the diverse biological sciences curriculum with laboratory courses in nucleic acid and protein techniques, along with cell biology, biochemistry, and electives such as bioinformatics, microbial biotechnology, immunology, developmental biology and virology. This concentration is ideal for students interested in biotechnology or biomedical research, and is also an excellent option for students planning future studies in the health professions.

## General Curriculum in Biology

General Curriculum in Biology is not a concentration but can be used to fulfill the unit requirements of a concentration. The General Curriculum provides the greatest flexibility allowing students to take coursework across all areas of biology. This breadth of knowledge across the biological sciences may be especially beneficial for students considering teaching biology at the secondary level. Students who do not declare a concentration will default to the General Curriculum.

## BS Marine Sciences

The degree is an integrative program designed to prepare students for advanced training or professional employment in public or private agencies concerned with marine-related issues. While this degree is based in Biological Sciences, the program includes faculty from other disciplines including chemistry, physics, mathematics, engineering, and computer science. The degree instills students with critical thinking and analytical skills in areas such as marine organism physiology, conservation, fisheries, oceanographic sampling and data networks. Through the use of experience-based learning including faculty-led research projects, students will develop essential knowledge as well as a solid foundation in community-oriented education in the interdisciplinary field of marine sciences. Students may not double major in Biological Science and Marine Science.

## BS Microbiology

Microbiology is the study of bacteria, viruses, fungi, and protists. Microorganisms are ubiquitous in the environment as important contributors to nutrient cycling, and many have symbiotic relationships with other organisms. Species of medical importance impact human and animal health as pathogens associated with infectious diseases. Additionally, microorganisms are critical research tools in fields such as molecular biology and genetics, and are used for large-scale production of many foods, pharmaceuticals, and industrial chemicals. Cal Poly is one of the few public universities in California offering a laboratory-intensive Bachelor of Science degree in Microbiology.

In the junior and senior years, in addition to genetics, cell biology, and microbial physiology, majors can take specialized courses in medical microbiology, immunology, microbial ecology, virology, and molecular biology laboratory techniques. Students also choose elective courses related to student interests and career goals in close consultation with their faculty advisors. Such goals may include graduate school or professional studies with further training through Clinical Laboratory Scientist (CLS) or Public Health Microbiologist certification programs. Graduates may also pursue post-baccalaureate employment in applied areas such as industrial microbiology, food and dairy microbiology, biotechnology, public health, epidemiology, or medical laboratory technology. Students may not double major in Biological Science and Microbiology.

## Biology Minor

The purpose of the minor is to help students from other disciplines acquire increased factual and conceptual knowledge in biology, an increased understanding of scientific methods and techniques used to study biology, and an increased ability to analyze biological topics in the news or in various jobs. Biological issues are important throughout modern life and particularly relevant in many careers, including

those in health-related businesses, agriculture, several engineering disciplines, city planning, teaching K-12 students, journalism, political science, psychology, and statistics. Students in more closely related majors such as biochemistry or kinesiology may also be interested in strengthening their biology background. In addition, an enhanced biology background helps students become better educated citizens regarding a variety of controversial issues in modern society (e.g., genetically-modified organisms in agriculture, human cloning, genetic discrimination, the pressures of population growth). The minor is open to any major except Biological Sciences, Marine Science, Microbiology, and Liberal Studies with a concentration in Biology.

## Biotechnology Minor

For information regarding the Biotechnology Minor, please see College of Science and Mathematics (<https://catalog.calpoly.edu/collegesandprograms/collegeofsciencemathematics/>) section.

## Cross Disciplinary Studies Minor in Bioinformatics

Through an inter-college collaboration, the Biology, Chemistry, Computer Science and Software Engineering, and Statistics Departments offer a Cross-Disciplinary Studies Minor (CDSM) in Bioinformatics. Bioinformatics lies at the intersection of computational sciences and biology. The CDSM in Bioinformatics creates a strong foundation in molecular biology as well as the design and applications of software and databases commonly used by computational biologists. The student will gain an understanding of how bioinformatic data are generated, organized, and used to gain insights into molecular life science.

The CDSM in Bioinformatics will provide the opportunity for biology, biochemistry, computer science and statistics students to identify solutions to biological questions using bioinformatics, to write and implement software on a bioinformatics project, to apply statistical analyses associated with bioinformatics, and to learn algorithms that can be useful for software development in the bioinformatics/computational biology field.

A student may not be awarded both the Cross Disciplinary Studies Minor in Bioinformatics and the Biotechnology minor.

Target majors: Biology, Biochemistry, Statistics, Computer Science and Software Engineering

## Microbiology Minor

This minor is designed to give students, from majors in which microbiology may be an important component, increased exposure to factual information, concepts, and skills and to provide those students a more complete understanding of the roles of microorganisms as they pertain to their major. Students in the allied health and related fields may expand their breadth of knowledge in microbial diseases, transmission and prevention, and immunologic responses. Students in applied fields of study such as Food and Dairy Sciences and various aspects of agriculture can gain additional information in pertinent topics such as the presence and role of microorganisms in water and wastewater treatment, in recycling of nutrients and soil fertility, in food processing, spoilage, and production, and in disease transmission. The minor is open to any major except Biological Sciences.

## Graduate Programs

# Master of Science Degree in Biological Sciences

### General Characteristics

This degree offers a strong background in the biological sciences. The program is designed to offer sufficient depth to strengthen the student's academic understanding and improve competence for:

1. many types of biological work that require advanced training beyond the bachelor's degree;
2. careers in industry and/or civil service;
3. teaching biological sciences at the elementary, secondary, and community college levels;
4. independent research in the field of specialization;
5. continued graduate work at other institutions.

### Prerequisites

Admission to this program requires a minimum grade point average of 3.0 in the last 90 quarter units attempted and two letters of recommendation from persons knowing your academic potential.

Information pertaining to specific departmental requirements for admission, classified, or conditionally classified may be obtained from the Director of the Graduate and Research Committee (Graduate Coordinator) of the Biological Sciences Department.

### Program of Study

The formal program of study for the degree must include 45 units of committee-approved graduate work, at least 30 units of which must be at the 500 level. Coursework must include 32 units taken within the Biological Sciences Department at Cal Poly. A grade point average of 3.0 or better is required from the combination of all courses included in the Formal Study Plan. A maximum of 12 units of BIO 590 Seminar in Biology, and a maximum of 3 units of BIO 500 Individual Study may be used as credit towards the degree. The culminating experience is a written and publicly presented independent and novel body of research, and nine units of BIO 599 Thesis.

## MS Biological Sciences, Specialization in Regenerative Medicine

**Characteristics.** Prepares students for careers in regenerative medicine and related fields. Specifically, our graduates are prepared for immediate employment in regenerative medicine, biotechnology or medical technology companies, or as research specialists/laboratory managers at universities and research institutes. Program graduates are also well-prepared to matriculate into biological sciences doctoral programs or graduate programs in the health professions.

**Culminating Experience.** Students who obtain a degree in the Master of Science in Biological Sciences with a specialization in Regenerative Medicine are not required to complete a "thesis" through BIO 599. In place of the thesis as a culminating experience, students complete a Project during a 9-month internship at a company or academic research laboratory (BIO 593). The Project Report and Project Presentation are evaluated by the student's Cal Poly and Internship Mentors; in addition, the Presentation is evaluated by the Program Director.

### BIO Courses

#### BIO 111. General Biology. 4 units

Term Typically Offered: F,W,SP,SU

2020-21 or later catalog: GE Area B2

2020-21 or later catalog: GE Area B3

2019-20 or earlier catalog: GE Area B2

2019-20 or earlier catalog: GE Area B4

Overview of fundamental concepts in biology and of scientific inquiry. Principles of cellular life and energetics, inheritance and genetic mechanisms, evolution and ecology. Emphasis on the relationship between biology and human affairs. Not open for major credit in Biological Sciences, Microbiology or Marine Sciences. Not open to students who have completed BIO 161. Course offered in hybrid format with classroom-based and online learning. 3 lectures, 1 laboratory. Fulfills GE Areas B2 and B3 (GE Areas B2 and B4 for students on the 2019-20 or earlier catalogs).

#### BIO 114. Plant Diversity and Ecology. 4 units

Term Typically Offered: W, SP

2020-21 or later catalog: GE Area B2

2020-21 or later catalog: GE Area B3

2019-20 or earlier catalog: GE Area B2

2019-20 or earlier catalog: GE Area B4

Plant diversity and ecology in aquatic and terrestrial plant communities including adaptations of plants to their environment. Identification of common, local native plants and plant communities, uses of native plants by Indigenous People, and human impacts on native plant communities. Field trip required. 2 lectures, 2 laboratories. Fulfills GE Areas B2 and B3 (GE Areas B2 and B4 for students on the 2019-20 or earlier catalogs).

#### BIO 123. Biology of Sex. 4 units

Term Typically Offered: W, SP

2020-21 or later catalog: GE Area B2

2019-20 or earlier catalog: GE Area B2

Fundamental principles of biology related to sexual reproduction: genetics, physiology, behavior, ecology and evolution of sex in a broad range of organisms. Not open for major credit in Biological Sciences, Microbiology, or Marine Sciences. Course may be offered in classroom-based or online format. 4 lectures. Fulfills GE Area B2.

#### BIO 150. Diversity and History of Life. 4 units

Term Typically Offered: F, W

2020-21 or later catalog: GE Area B2

2020-21 or later catalog: GE Area B3

2019-20 or earlier catalog: GE Area B2

2019-20 or earlier catalog: GE Area B4

Overview of the history, diversity and genetic relatedness of life on Earth. Broad-scale evolutionary framework of the organization and expansion of life on Earth. 3 lectures, 1 laboratory. Fulfills GE Areas B2 and B3 (GE Areas B2 and B4 for students on the 2019-20 or earlier catalogs).

**BIO 161. Introduction to Cell and Molecular Biology. 4 units**

Term Typically Offered: F,W,SP,SSU

2020-21 or later catalog: GE Area B2

2020-21 or later catalog: GE Area B3

2019-20 or earlier catalog: GE Area B2

2019-20 or earlier catalog: GE Area B4

Recommended: CHEM 110 or CHEM 124 or CHEM 127.

Fundamentals of cellular biology with an emphasis on the molecular perspective of life: biomolecules, cellular energetics, cell structure and reproduction, molecular mechanisms of genetics and gene expression. 3 lectures, 1 laboratory. Fulfills GE Areas B2 and B3 (GE Areas B2 and B4 for students on the 2019-20 or earlier catalogs).

**BIO 162. Introduction to Organismal Form and Function. 4 units**

Term Typically Offered: W, SP

Prerequisite: BIO 161. Recommended: CHEM 110 or CHEM 111 or CHEM 124 or CHEM 127.

Fundamentals of the structure and physiology of tissues and organs of plants and animals: energy acquisition and food distribution, gas exchange and fluid transport, and sensing and responding to the environment. 3 lectures, 1 laboratory.

**BIO 200. Special Problems for Undergraduates. 1-2 units**

Term Typically Offered: F,W,SP,SSU

CR/NC

Prerequisite: Consent of department chair.

Individual investigation, research, studies or surveys of selected problems. Intended for lower division students in the Biological Sciences Department. Total credit limited to 12 units, with a maximum of 2 units per quarter. Credit/No Credit grading only.

**BIO 202. Orientation to Biotechnology. 2 units**

Term Typically Offered: W

Prerequisite: Completion of a course with a BIO, BOT or MCRO prefix and a course with a CHEM prefix.

Introduction to the diversity of fields in biotechnology. Applications in agriculture, nutrition, medicine and environmental problems. 1 lecture, 1 activity. Crosslisted as BIO/CHEM 202.

**BIO 211. Biology of Plants and Animals. 4 units**

Term Typically Offered: W, SP

Prerequisite: BIO 111; for Liberal Studies majors only. Recommended: STAT 130 or STAT 217.

Plant and animal anatomy, physiology, diversity and life cycles. How plants and animals acquire nutrients, reproduce, and adapt to environments. Emphasis on hands-on activities and model organisms suited for the elementary classroom. 3 lectures, 1 laboratory. Not open for major credit in Biological Sciences, Microbiology, or Marine Sciences.

**BIO 213. Life Science for Engineers. 2 units**

Term Typically Offered: F, W, SP

2020-21 or later catalog: GE Area B2

2019-20 or earlier catalog: GE Area B2

Corequisite: BMED/BRAE 213. Recommended: CHEM 124.

Fundamentals of life sciences: energetics, cell biology, genetics, microbiology, organismal biology, and ecology. Not open for major credit in Biological Sciences, Microbiology, or Marine Sciences. 2 lectures. Fulfills GE B2.

**BIO 222. Biodiversity of California. 4 units**

Term Typically Offered: F, W, SP

2020-21 or later catalog: GE Area B2

2019-20 or earlier catalog: GE Area B2

Recommended: Completion of GE Area A.

Foundations and importance of California's biological diversity from historical and modern contexts. Overview of California's diverse habitats, wildlife and their adaptations. Current challenges to preserving California's biodiversity. Concepts in quantification, conservation and appreciation for California's biodiversity. 4 lectures. Fulfills GE Area B2.

**BIO 227. Wildlife Conservation Biology. 4 units**

Term Typically Offered: F, W, SP

2020-21 or later catalog: GE Area B2

2019-20 or earlier catalog: GE Area B2

Sustainability Focused

Recommended: Completion of GE Area A2.

Wildlife biology and philosophies of conservation. Basic principles of ecology and evolution. Practices applied to wildlife management. Current problems involving people-wildlife interactions with special reference to world biodiversity. Not open for major credit in Biological Sciences, Microbiology, or Marine Sciences. Not open to students with credit in BIO 363. 4 lectures. Fulfills GE Area B2.

**BIO 231. Human Anatomy and Physiology I. 5 units**

Term Typically Offered: F, W, SP

Prerequisite: BIO 111 or BIO 161; CHEM 110, CHEM 111, CHEM 124, CHEM 127, or PSC 102.

Structure and function of the skeletal, muscular, nervous, endocrine, and integumentary systems. Molecular, cellular, and organ system levels of organization. Lab includes study of prosected human cadavers. Not intended for Biological Sciences majors. May be taken after BIO 232. 4 lectures, 1 laboratory.

**BIO 232. Human Anatomy and Physiology II. 5 units**

Term Typically Offered: F,W,SP,SSU

Prerequisite: BIO 111 or BIO 161; CHEM 110, CHEM 111, CHEM 124, CHEM 127, or PSC 102.

Structure and function of the circulatory, immune, respiratory, digestive, urinary, and reproductive systems. Molecular, cellular, and organ system levels of organization. Lab includes study of prosected human cadavers. Not intended for Biological Sciences majors. May be taken before BIO 231. 4 lectures, 1 laboratory.

**BIO 253. Health Professions Shadowing. 1 unit**

Term Typically Offered: F

CR/NC

Prerequisite: Consent of instructor.

Observation in a healthcare setting. Students will shadow healthcare practitioners on campus or in a community setting. Specific placement depend on practitioner availability. Total credit limited to 2 units with a maximum of 1 unit per quarter. Credit/No Credit grading only. 1 activity. Priority to BIO and MCRO majors.



**BIO 263. Introductory Ecology and Evolution. 4 units**

Term Typically Offered: F, SP

Prerequisite: BIO 160 or BIO 161.

Basic concepts in ecology and evolution. Relationships among organisms in populations, communities and ecosystems, structures and dynamics of populations, communities and ecosystems, ecosystem inputs and energy flows, nutrient cycling, biogeography, population genetics, evolution, patterns of biodiversity and issues in conservation biology. 3 lectures, 1 laboratory.

**BIO 270. Selected Topics. 1-4 units**

Term Typically Offered: TBD

Prerequisite: Consent of instructor.

Directed group study of selected topics. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 lectures.

**BIO 300. Research Experience for Undergraduates. 1-2 units**

Term Typically Offered: F,W,SP,SU

CR/NC

Prerequisite: Consent of instructor. Recommended: STAT 218.

Laboratory, field, or biology education research experience. Development of research skills and techniques. Interested students consult with a faculty member prior to enrolling to clarify expectations and deliverables. Total major credit limited to 6 units, with a maximum of 2 units per quarter. Total credit limited to 12 units. Credit/No Credit grading only.

**BIO 301. Service Learning in the Health Professions. 3 units**

Term Typically Offered: W

Prerequisite: BIO 161 or MCRO 221 or MCRO 224; completion of GE Area A with a grade of C- or better; one course in GE Area D2 (or in GE Area D3 for students on the 2019-20 or earlier catalogs); and consent of instructor.

Framework for understanding the implications of service in different health-related settings through discussion and participation in a local service project. Social determinants of health, cultural competency and unconscious bias, identity/intersectionality, and health needs of different populations. 2 lectures, 1 laboratory.

**BIO 302. Human Genetics. 4 units**

Term Typically Offered: F, W, SP

2020-21 or later: Upper-Div GE Area B

2019-20 or earlier catalog: GE Area B5, B6, or B7

Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs); and one of the following courses: ASCI 112, BIO 111, BIO 123, BIO 161, BIO 213, or BOT 121. Recommended: STAT 217, STAT 218, STAT 251, STAT 305, STAT 312, STAT 321, or STAT 350.

Basic principles of human inheritance, including the transmission of genetic traits, chromosomal abnormalities and their effects, gene structure and function, mutations and mutagenic agents, cancer genetics, population genetics, and principles of genetic counseling. Not open for major credit in Biological Sciences, Microbiology, or Marine Sciences. Not open to students with credit in BIO 303 or BIO 351. 4 lectures. Fulfills GE Area Upper-Division B (GE Areas B5, B6, or B7 for students on the 2019-20 catalog).

**BIO 303. Survey of Genetics. 4 units**

Term Typically Offered: F, W, SP

Prerequisite: BIO 111 or BIO 161 or BOT 121. Recommended: STAT 218.

Principles of heredity and variation. Transmission genetics; molecular mechanisms of inheritance and gene expression. Not open to Biological Sciences, Microbiology, or Marine Sciences majors. Not open to students with credit in BIO 351. Credit will be granted in only one of the following courses: BIO 302 or BIO 303. 4 lectures.

**BIO 305. Biology of Cancer. 4 units**

Term Typically Offered: F

2020-21 or later: Upper-Div GE Area B

2019-20 or earlier catalog: GE Area B5, B6, or B7

Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; one BIO or MCRO course in GE Area B2; completion of GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs).

Introduction to the causes, characteristics and treatment of human cancer. Effects of carcinogens and radiation; the genetics of cancer; molecular, cellular and physiological changes in common cancers; conventional chemotherapy and new treatments. Not open for major credit in Biological Sciences, Microbiology, Marine Sciences, or Biochemistry. 4 lectures. Fulfills GE Area Upper-Division B (GE Areas B5, B6, or B7 for students on the 2019-20 catalog).

**BIO 308. Genetic Engineering Technology. 4 units**

Term Typically Offered: SP

2020-21 or later: Upper-Div GE Area B

2019-20 or earlier catalog: GE Area B5, B6, or B7

Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; and completion of GE Areas B1 through B4, with a grade of C- or better in one course in GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs); and one of the following courses: CHEM 110, CHEM 124, or CHEM 127.

Introduction to the biology, methodology, and techniques used in genetic engineering. Potential benefits and problems in application within agriculture, nutrition, medicine and environmental context, including the underlying ethical questions. Not open to students with credit in CHEM 373, or to Biological Sciences, Marine Sciences, or Microbiology majors. 4 lectures. Crosslisted as BIO/CHEM 308. Fulfills GE Area Upper-Division B (GE Areas B5, B6, or B7 for students on the 2019-20 catalog).

**BIO 321. Mammalogy. 4 units**

Term Typically Offered: F, W

Prerequisite: one of the following: BIO 162, BIO 263, NR 306 or ASCI 239.

Ecology, behavior, physiology, functional morphology, and evolution of mammals. Classification and identification of mammals, with emphasis on California species. 2 lectures, 2 laboratories.

**BIO 322. Ichthyology. 4 units**

Term Typically Offered: SP

Prerequisite: BIO 162.

Phylogeny, anatomy, functional morphology, physiology, and ecology of marine and freshwater fishes. Special reference to local and economically important species. Laboratory emphasis on taxonomy of California species, especially marine groups. Field trip required. 3 lectures, 1 laboratory.

**BIO 323. Ornithology. 4 units**

Term Typically Offered: SP

Prerequisite: BIO 162 or BIO 263 or BIO 427 or ASCI 239.

Classification and identification of birds, with emphasis on California species. Functional morphology, physiology, ecology, behavior and census methods. Field trips may require meeting in the morning before scheduled lab time. 2 lectures, 2 laboratories.

**BIO 324. Herpetology. 4 units**

Term Typically Offered: SP

Prerequisite: BIO 160 and BIO 162.

Living and extinct reptiles and amphibians; an adaptive approach to their diversity, biology, and classification. 2 lectures, 2 laboratories.

**BIO 327. Wildlife Ecology. 4 units**

Term Typically Offered: TBD

Prerequisite: BIO 263 or NR 306. Recommended: STAT 217 or STAT 218.

Principles of ecology as applied to the study of wild vertebrates and their habitats. Emphasis on techniques for collecting and analyzing field data and how these data apply to the study and management of wildlife. Use of the literature, inventory of plants and animal populations, use of maps and databases, quantifying diet and habitat use, determining sex and age and nutritional condition, capture and marking techniques, non-invasive sampling methods. 3 lectures, 1 laboratory.

**BIO 329. Vertebrate Field Zoology. 4 units**

Term Typically Offered: TBD

Prerequisite: Junior standing; BIO 162 or BIO 263 or BIO 427 or ASCI 239.

Identification and natural history of terrestrial vertebrates, with emphasis on field studies and local species. Field trips may require meeting in the morning before scheduled lab time. 2 lectures, 2 laboratories.

**BIO 330. Extended Field Biology Activity. 1-3 units**

Term Typically Offered: TBD

Corequisite: Enrollment in corresponding field biology course.

Minimum of two days of field instruction in places with significant biological diversity, and an individual or group project. Focus on field notebooks, field identification, survey methods, experimental design, and significant habitat types for various groups of organisms. The Class Schedule will list the topic of the associated field biology course. Total credit limited to 6 units, each associated with a different field biology course, with no more than 4 units applied as advisor approved electives. Field trip required. 1 to 3 activities.

**BIO 335. General Entomology. 4 units**

Term Typically Offered: F

Prerequisite: BIO 160, BIO 211, or PLSC 313. Recommended: BIO 162.

Introduction to the study of insects. Structure, major orders and families of insects, life histories, medical, and economic importance. Insect collection required. 2 lectures, 2 laboratories.

**BIO 336. Invertebrate Zoology. 4 units**

Term Typically Offered: W

Prerequisite: BIO 160 and BIO 162.

Invertebrate groups of animals with emphasis on taxonomy, morphology, distribution, and economic importance. 2 lectures, 2 laboratories, and fieldwork.

**BIO 351. Principles of Genetics. 5 units**

Term Typically Offered: F, W, SP

Prerequisite: BIO 161; CHEM 216, CHEM 312, or CHEM 316.

Recommended: BIO 263; STAT 217 or STAT 218.

Principles of genetics and genetic analysis, including underlying molecular mechanisms. Subjects include gene structure and function, inheritance patterns, regulation of gene expression, mutation, recombination, recombinant DNA technology, and an introduction to population genetics. 5 lectures.

**BIO 361. Principles of Animal Physiology. 4 units**

Term Typically Offered: F, W, SP

Prerequisite: BIO 162; and CHEM 216, CHEM 312 or CHEM 316.

Fundamental principles of animal physiology, including cellular mechanisms and integration to whole animals including humans. Membrane transport, fluid/salt balance, excitable cells, metabolic rate, temperature, gas exchange and circulation. 3 lectures, 1 laboratory.

**BIO 363. Principles of Conservation Biology. 4 units**

Term Typically Offered: F, W, SP

Sustainability Focused

Prerequisite: BIO 263 or NR 306, or graduate standing in Biological Sciences.

Foundational concepts in the conservation of wild organisms and their habitats. Quantification and valuation of biological diversity, current threats to diversity, and approaches to better understand and address these threats, across terrestrial, freshwater, and marine environments. 4 lectures. Formerly BIO 401.

**BIO 400. Special Problems for Advanced Undergraduates. 1-2 units**

Term Typically Offered: F,W,SP,SU

Prerequisite: Consent of instructor. Recommended: STAT 218.

Investigation, research, studies, or surveys of biological problems by students working with faculty. Interested students should consult with a faculty member prior to enrolling to clarify expectations and deliverables. Total major credit limited to 6 units, with a maximum of 2 units per quarter. Total credit limited to 12 units.

**BIO 405. Developmental Biology. 4 units**

Term Typically Offered: SP

Prerequisite: BIO 161, BIO 162, and BIO 303 or BIO 351 or CHEM 373.

Events and mechanisms of embryonic development, including fertilization, morphogenesis, cell differentiation, and organogenesis, with emphasis on differential gene expression in model organisms. 3 lectures, 1 laboratory.

**BIO 406. Advanced Anatomy and Physiology: Neuroscience. 4 units**

Term Typically Offered: F, W

Prerequisite: BIO 361; CHEM 331 or STAT 218; PHYS 123 or PHYS 133; or graduate standing in Biological Sciences.

Anatomy and physiology of nervous systems, including electrophysiology, molecular and cellular mechanisms of neurotransmission, and interactions between the nervous system and other body systems, including integumentary and digestive, with an emphasis on humans and other vertebrates. Includes human cadaver study. 3 lectures, 1 laboratory.

**BIO 407. Advanced Anatomy and Physiology: Endocrinology. 4 units**

Term Typically Offered: F, SP, SU

Prerequisite: BIO 361; CHEM 331 or STAT 218; or graduate standing in Biological Sciences.

Anatomy and physiology of the endocrine system and hormones, and interactions with body systems including digestive and reproductive systems, with an emphasis on humans and other vertebrates. Course may be offered in classroom-based or online format. 4 lectures.

**BIO 408. Advanced Anatomy and Physiology: Cardiorespiratory and Renal. 4 units**

Term Typically Offered: F, W

Prerequisite: BIO 361; CHEM 331 or STAT 218; or graduate standing in Biological Sciences.

Anatomy and physiology of the cardiovascular, respiratory, and renal systems, with an emphasis on humans and other vertebrates. Discussion of health and disease states and responses to exercise and environmental factors. Includes human cadaver study. 3 lectures, 1 laboratory.

**BIO 409. Advanced Anatomy and Physiology: Muscle and Locomotion. 4 units**

Term Typically Offered: W, SP

Prerequisite: BIO 361; CHEM 331 or STAT 218; PHYS 121 or PHYS 141; or graduate standing in Biological Sciences.

Anatomy and physiology of musculoskeletal systems, including energetics and biomechanics of locomotion. Discussion of invertebrates and vertebrates with emphasis on humans. Includes human cadaver study. 3 lectures, 1 laboratory.

**BIO 410. Functional Histology. 4 units**

Term Typically Offered: SP

Prerequisite: ASCI 229 or BIO 231 or BIO 232 or BIO 361 or graduate standing in Biological Sciences.

Functional microscopic anatomy of principal tissues and organs of vertebrates, including humans. Structural studies to determine mechanisms underlying physiological processes and their clinical applications in medicine. 2 lectures, 2 laboratories.

**BIO 411. Advanced Human Gross Anatomy. 2 units**

Term Typically Offered: SU

Prerequisite: One of the following courses with a grade of C- or better: BIO 231, BIO 232, or BIO 361; and consent of instructor.

Human gross anatomy using human cadaver dissection from a regional perspective. Dissection of the musculo-skeletal and nervous tissues, vasculature, and viscera of body regions including: head, neck, torso, extremities, and body cavities. 2 laboratories.

**BIO 413. Evolutionary Medicine. 4 units**

Term Typically Offered: TBD

Prerequisite: BIO 263; and BIO 303 or BIO 351. Recommended: MCRO 224.

Principles and mechanisms of biological evolution in the context of human health. Microevolutionary and macroevolutionary processes, adaptation, phenotypic plasticity, biogeographic patterns of allele frequencies, tradeoffs. Focus on human health including host-pathogen coevolution, cancer, mental health, obesity, drug metabolism, evolutionary history. 4 lectures. Not open to students with credit in BIO 414.

**BIO 414. Evolution. 4 units**

Term Typically Offered: FW,SPSU

Prerequisite: BIO 263; and BIO 303 or BIO 351. Recommended: BIO 327, BOT 326, or MSCI 300.

Principles, theories and mechanisms of biological evolution of plants, animals and microorganisms. Core principles include microevolutionary and macroevolutionary processes, adaptation, phenotypic plasticity, biogeographic patterns of allele frequencies, tradeoffs. Not open to students with credit in BIO 413. 4 lectures.

**BIO 415. Biogeography. 4 units**

Term Typically Offered: W

Prerequisite: BIO 263 or graduate standing in Biological Sciences.

Plant and animal distribution patterns in terrestrial and aquatic systems in relation to past and present physical and biotic factors. Methods to determine local and global distribution patterns of biota. Role of humans in past, present and future distributions of organisms. 4 lectures.

**BIO 416. Climate Change Biology. 4 units**

Term Typically Offered: F

Prerequisite: BIO 160; BIO 162; and BIO 263.

Biological consequences of climate change. Effects on cellular and organismal physiology and geographic distribution of organisms. Biodiversity, community and ecosystem impacts. Introduction to atmospheric chemistry, climate dynamics, and consequences for human populations. Possible biological mitigation strategies to reduce CO2 emissions. Field trip required. 3 lectures, 1 laboratory.

**BIO 421. Wetlands. 4 units**

Term Typically Offered: TBD

Prerequisite: BOT 121 or BIO 162; CHEM 127; and SS 120 or SS 130.

Recommended: one of the following: BIO 327, BOT 313, BOT 326, MSCI 300, NR 304, NR 305, or NR 306.

The formation, characteristics, and functions of wetlands. Genesis of hydric soils. Plant adaptations to saturated soils. Wetlands as wildlife habitat. Policies and social issues associated with wetlands. The procedures of wetland delineations. 3 lectures, 1 laboratory. Crosslisted as BIO/NR/SS 421.

**BIO 424. Organizing and Teaching Science. 4 units**

Term Typically Offered: TBD

Prerequisite: Admission to the Single Subject Credential Program.

Techniques, aims and objectives in the teaching of physical and life sciences at the secondary level. Selection and organization of teaching material, including strategies for English language learners (ELL) and special needs students. Evaluation of results. 3 lectures, 1 activity. Crosslisted as BIO/PSC 424.

**BIO 425. Clinical Experience in Teaching Science Seminar. 2 units**

Term Typically Offered: TBD

CR/NC

Prerequisite: Acceptance into the Single Subject Credential Program in Science. Concurrent: EDUC 469 or EDUC 479.

Principles and practices in effective teaching of science at the middle and high school level, learning theories, curriculum content and structure, classroom issues, and the teaching profession. Credit/No Credit grading only. Total credit limited to 4 units. 2 seminars. Crosslisted as BIO/PSC 425.

**BIO 426. Immunology. 4 units**

Term Typically Offered: W, SP

Prerequisite: BIO 351 or CHEM 373. Recommended: CHEM 313 or CHEM 371.

Principles of molecular and cellular immunology. Emphasis on molecular regulation of immune cell development, including generation of unique receptors, lymphocyte signal transduction and selection, programmed cell death and regulation of immune responses. Discussion and demonstration of roles of immunology in disease and as diagnostic tools. 3 lectures, 1 laboratory.

**BIO 427. Wildlife Management. 4 units**

Term Typically Offered: F

Prerequisite: One of the following upper-division ecology courses: BIO 327, BIO 363, BIO 401, BIO 444, BOT 326, MSCI 300, or NR 306, or graduate standing in Biological Sciences.

Important habitats, such as riparian, wetlands, and habitat features important to wildlife, such as vegetation types and snags. Basic concepts of wildlife management. Emphasis on planning and designing habitats to meet the needs of wildlife. 3 lectures, 1 laboratory.

**BIO 428. Hematology. 4 units**

Term Typically Offered: W

Prerequisite: one of the following: BIO 351, BIO 302, BIO 303, CHEM 373, or graduate standing in Biological Sciences. Recommended: BIO 361 or ZOO 332 or BMED 460; and CHEM 313 or CHEM 371.

Development and function of blood as a tissue. Composition, function, and mechanisms of formation and destruction of blood components in health and disease. Methods for examination of blood. 3 lectures, 1 laboratory.

**BIO 429. Parasitology. 4 units**

Term Typically Offered: F

Prerequisite: BIO 160 and BIO 161; or MCRO 221; or MCRO 224; or graduate standing in Biological Sciences.

External and internal parasites of man and animals. Life history. Parasite-host relationships. Control and recognition of species of clinical importance. 2 lectures, 2 laboratories.

**BIO 434. Environmental Physiology. 4 units**

Term Typically Offered: F, SP

Sustainability Focused

Prerequisite: BIO 162, or graduate standing in Biological Sciences. Recommended: BIO 263.

Comparative physiological mechanisms involved in the regulation of oxygen uptake, water and ion balance, and temperature regulation in animals. Emphasis is placed on physiological adaptations which maintain or restore homeostasis in animals which are subjected to environmental changes. 3 lectures, 1 laboratory.

**BIO 435. Plant Physiology. 4 units**

Term Typically Offered: SP

Prerequisite: BOT 121 or BIO 162. Recommended: BIO 161 or BIO 303; CHEM 312 or CHEM 216.

Consideration of the principal physiological and biochemical processes of plants with emphasis on water relations, mineral nutrition, photosynthesis, and the physiology of plant development. 3 lectures, 1 laboratory.

**BIO 441. Bioinformatics Applications. 4 units**

Term Typically Offered: F, SP

Prerequisite: BIO 302, BIO 303, BIO 351, or CHEM 373.

Introduction to new problems in molecular biology and current computer applications for genetic database analyses. Use of software for: nucleic acid, genome and protein sequence analysis; genetic databases, database tools; industrial applications in bioinformatics; ethical and societal concerns. 3 lectures, 1 laboratory. Crosslisted as BIO/CHEM 441.

**BIO 442. Behavioral Ecology. 4 units**

Term Typically Offered: F

Prerequisite: BIO 263, or graduate standing in Biological Sciences.

Behavioral adaptations of animals to their environment and way of life. Analysis of behavior patterns, use of patterns in clarifying evolutionary and ecological relationships. 3 lectures, 1 laboratory.

**BIO 444. Population Ecology. 4 units**

Term Typically Offered: TBD

Prerequisite: BIO 263 or NR 306.

Growth, fluctuations, balance, and natural mechanisms controlling wild populations, and methods for assessing their interconnectedness. Field trip may be required. 3 lectures, 1 laboratory.

**BIO 445. Community Ecology. 4 units**

Term Typically Offered: W

Prerequisite: BIO 160, BIO 162, BIO 263, and STAT 218; or graduate standing in Biological Sciences. Recommended: BIO 327, BIO 363, BIO 401, BOT 326, or MSCI 300.

Principles of ecology at the community level including the mechanisms that structure ecological communities, and the quantitative methods used to study community ecology such as diversity metrics, community composition analyses, interaction strengths and the application of statistics to field and experimental studies. 3 lectures, 1 laboratory.

**BIO 446. Ecosystem Ecology. 4 units**

Term Typically Offered: SP

Sustainability Focused

Prerequisite: BIO 263, BOT 326, or NR 306; and STAT 218, or Graduate standing in Biological Sciences. Recommended: BIO 327, BIO 363, BIO 401, MSCI 300, SS 120, or SS 121.

Advanced ecosystem ecology and biology, and the interactions of biological communities with the abiotic environment. Emphasis on climate change, ecosystem services, and major fluxes and pools of organic elements. 4 lectures.

**BIO 447. Spatial Ecology. 4 units**

Term Typically Offered: SP

Prerequisite: BIO 263; GEOG 318 or NR/LA 218; and STAT 218; or graduate standing in Biological Sciences. Recommended: BIO 327, BOT 326, or MSCI 300; and STAT 313 or STAT 513.

Effect of geographical space on distribution and abundance of organisms. Analysis of movement, home ranges, connectivity, range limits, and factors that shape these processes. Survey of available tools and data to answer questions in the discipline. 3 lectures, 1 lab.



**BIO 448. Geoecology. 4 units**

Term Typically Offered: SP

Prerequisite: BIO 114, BIO 162, BIO 211, or BOT 121; and BIO 227, BIO 263, NR 305, NR 306, or SS 321. Recommended: GEOL 102 or SS 120.

Exploration of the role of landforms and lithology in shaping species and community diversity, and ecological and evolutionary processes. Plant-microbe-soil relations, heavy metal tolerance, conservation of rock outcrop plants and associated biota. Green technologies such as phytoremediation and agromining. Field trip required. 3 lectures, 1 laboratory.

**BIO 450. Undergraduate Laboratory Assistantship. 1-4 units**

Term Typically Offered: F, W, SP

CR/NC

Prerequisite: Consent of instructor and department chair.

Assisting the instructor in teaching and supervising undergraduate laboratories in the Biological Sciences Department. Total credit limited to 8 units, with a maximum of 4 units per quarter. Credit/No Credit grading only.

**BIO 452. Cell Biology. 4 units**

Term Typically Offered: F, W, SP

Prerequisite: BIO 351 or CHEM 373; and CHEM 216, CHEM 312 or CHEM 316. Recommended: CHEM 313 or CHEM 371.

Introduction to cell structure and function, energy conversions, protein sorting, signaling, cytoskeleton, cell adhesion, and the cell cycle. 3 lectures, 1 laboratory.

**BIO 461. Senior Project - Research Proposal. 2 units**

Term Typically Offered: F,W,SP,SU

Prerequisite: Completion of GWR; STAT 218; and junior standing.

Guided course with group meetings, leading to completion of a written research proposal. Review of scientific literature and analysis of existing experimental results from published peer-reviewed articles in biology. Includes oral presentations. Course may be offered in classroom-based, online, or hybrid format. 2 activities.

**BIO 462. Senior Project Research Experience. 2 units**

Term Typically Offered: F,W,SP,SU

Prerequisite: Completion of GWR; STAT 218; junior standing; and consent of instructor. Recommended: BIO 400.

Completion of research, data analysis, or other substantial project as a capstone for the major. Student identifies faculty mentor before enrolling to develop project proposal and clarify deliverables. Typically a continuation of BIO 400. Written project report and/or presentation required.

**BIO 463. Honors Research. 2 units**

Term Typically Offered: F,W,SP,SU

Prerequisite: BIO 461 or BIO 462; and consent of instructor.

Continuation of research experience leading to completion of advanced research in the biological sciences. Topic selected and conducted in consultation with a faculty mentor. Results presented as a written report and/or oral presentation in a public forum.

**BIO 470. Selected Advanced Topics. 1-4 units**

Term Typically Offered: F, SP

Prerequisite: Consent of instructor.

Directed group study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 lectures.

**BIO 471. Selected Advanced Laboratory. 1-4 units**

Term Typically Offered: F, SU

Prerequisite: Consent of instructor.

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topics selected. Total credit limited to 8 units. 1 to 4 laboratories.

**BIO 472. Current Topics in Biological Research. 1-4 units**

Term Typically Offered: F, SP

Prerequisite: Junior standing.

Applications of biological research topics. Discussions of how selected discoveries in biological research formed the basis for, and were developed into, practical applications, currently accepted theories, generally utilized techniques or decisions affecting society and political policies. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 seminars.

**BIO 475. Molecular Biology Laboratory. 3 units**

Term Typically Offered: F, W, SP

Prerequisite: BIO 161, and grade of C- or better in BIO 351 or CHEM 373 or consent of instructor.

Introduction to techniques used in molecular biology and biotechnology; DNA extraction, characterization, cloning, Southern blotting, reverse transcription, polymerase chain reaction, and sequencing analysis. 1 lecture, 2 laboratories. Crosslisted as BIO/CHEM 475.

**BIO 476. Gene Expression Laboratory. 3 units**

Term Typically Offered: SP

Prerequisite: BIO/CHEM 475 with a grade of C- or better or consent of instructor; CHEM 313 or CHEM 371, or graduate standing in Biological Sciences.

Heterologous gene expression of a recombinant protein in a microbial system: gene cloning, construction of expression plasmid, DNA sequence analysis, transformation of microbial host, selection and analysis of transformed host cells, expression and purification of recombinant protein. 1 lecture, 2 laboratories. Crosslisted as BIO/CHEM 476.

**BIO 485. Cooperative Education Experience. 6 units**

Term Typically Offered: F,W,SP,SU

CR/NC

Prerequisite: Sophomore standing and consent of instructor.

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Major credit limited to 4 units; total credit limited to 12 units. Credit/No Credit grading only.

**BIO 495. Cooperative Education Experience. 12 units**

Term Typically Offered: F,W,SP,SU

CR/NC

Prerequisite: Sophomore standing and consent of instructor.

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Major credit limited to 4 units; total credit limited to 12 units. Credit/No Credit grading only.

**BIO 500. Individual Study. 1-4 units**

Term Typically Offered: F,W,SP,SU

Prerequisite: Graduate standing in Biological Sciences and consent of instructor.

Advanced study planned and completed with the approval of and under the direction of a member of the department faculty. A written scholarly presentation of the results of each BIO 500 project must be included in the graduate student's departmental file. Total degree credit limited to 3 units. Total credit limited to 12 units.

**BIO 501. Molecular & Cellular Biology. 4 units**

Term Typically Offered: F

Prerequisite: Graduate standing in Biological Sciences or consent of instructor.

Principles of molecular and cellular biology including gene function and regulation, energetics, protein trafficking, cytoskeleton, signaling, adhesion, and the cell cycle. 3 lectures, 1 laboratory.

**BIO 502. Biology of Organisms. 4 units**

Term Typically Offered: W

Prerequisite: Graduate standing in Biological Sciences, or consent of instructor.

Principles of and current topics in organismal biology, with an emphasis on physiology (including organ systems), behavior, and responses to the environment. 3 lectures, 1 laboratory.

**BIO 503. Population Biology. 4 units**

Term Typically Offered: F

Prerequisite: Graduate standing in Biological Sciences or consent of instructor.

Considerations of theory and practice in population ecology, evolutionary biology, and biosystematics. 3 lectures, 1 laboratory.

**BIO 509. Communicating Biology to General Audiences. 1 unit**

Term Typically Offered: SP

Prerequisite: Graduate standing.

Key issues for scientists communicating with the general public. Introduction to principles, examination of case studies, and practical application in outreach projects. Intended for graduate students in biology and related disciplines. 1 activity.

**BIO 524. Developmental Biology Seminar. 2 units**

Term Typically Offered: TBD

Prerequisite: Graduate standing in Biological Sciences or consent of instructor. Recommended: BIO 501.

Principles and selected topics in developmental biology. Issues of differentiation, morphogenesis, and pattern formation; specific topics chosen by participants. 2 seminars.

**BIO 534. Principles of Stem Cell Biology. 2 units**

Term Typically Offered: F

Prerequisite: Graduate standing in Biological Sciences, Biomedical Engineering, or Agriculture, or consent of instructor. Recommended: BIO 452 or BIO 501.

Principles of stem cell biology including characteristics, types, roles in development, therapeutic uses, historical perspectives and ethical issues. 2 seminars.

**BIO 537. Advanced Behavioral Ecology. 2 units**

Term Typically Offered: W

Prerequisite: BIO 442 or graduate standing.

Function and evolution of behavioral traits as they relate to ecological phenomena. Behaviors include habitat selection, migration, spacing mechanisms, mating strategies, foraging, aggression, parasitism, altruism, communication, and comparative social systems. Examples from the primary literature. Includes oral presentations. 2 seminars.

**BIO 560. Graduate Professional Seminar. 2 units**

Term Typically Offered: F

Prerequisite: Graduate standing in Biological Sciences.

Preparation for a successful career in biology within or outside of academia through skills development in professional communication and presentation, the peer-review process, mentorship, scientific ethics. 2 seminar.

**BIO 561. Proposal Writing for Biological Research. 3 units**

Term Typically Offered: W

Prerequisite: Graduate standing in Biological Sciences or consent of instructor.

Written and oral presentations of a proposal for research in biology including a literature review. 3 seminars.

**BIO 562. Data Management and Visualization in Biology. 3 units**

Term Typically Offered: F

Prerequisite: STAT 218 and graduate standing in Biological Sciences; or consent of instructor. Recommended: Experience with Excel and R.

Data management and visualization tools for research. Introduction to data management in menu driven applications. Extensive work with data management in code-driven applications. Advanced visualization techniques for data presentation and publication. 3 seminars.

**BIO 570. Selected Topics in Biology. 1-4 units**

Term Typically Offered: TBD

Prerequisite: Graduate standing in Biological Sciences or consent of instructor.

Directed group study of selected topics for graduate students. The Class Schedule will list topics for selection. Total credit limited to 12 units. 1 to 4 seminars.

**BIO 571. Selected Advanced Laboratory. 1-4 units**

Term Typically Offered: TBD

Prerequisite: Graduate standing or consent of instructor.

Directed group laboratory study of selected topics for advanced students. Open to undergraduate and graduate students. The Class Schedule will list topic selected. Total credit limited to 8 units. 1 to 4 laboratories.

**BIO 574. Teaching Strategies for College Biology Laboratories. 1 unit**

Term Typically Offered: F

CR/NC

Prerequisite: Graduate standing in Biological Sciences.

Concepts of teaching and learning related to instructor performance in college biology laboratory classes. Introduction to teaching strategies, managing a classroom, writing exam questions, and science education research for the laboratory class setting. Credit/No Credit grading only. 1 activity.

**BIO 575. College Biology Teaching Practicum. 1-2 units**

Term Typically Offered: F, W, SP

CR/NC

Prerequisite: Graduate standing; Department Chair and Graduate Coordinator approval required.

Supervised teaching-related activities associated with undergraduate classes in the Biological Sciences Department including assessment, curriculum development, implementing novel teaching approaches. Total credit limited to 2 units. Credit/No Credit grading only.

**BIO 583. Research Experience for Regenerative Medicine Students. 2 units**

Term Typically Offered: SP

Prerequisite: Graduate standing in the Specialization in Regenerative Medicine for the MS in Biological Sciences; or Specialization in Regenerative Medicine for the MS in Biomedical Engineering; or the Animal Science Specialization for the MS in Agriculture.

Independent research experience in biological or biomedical research. Proposal writing and literature review; experimental design, implementation and troubleshooting; oral and poster presentations. 1 seminar and supervised work. Crosslisted as ASCI/BIO/BMED 583. Formerly ASCI/BIO/BMED 594.

**BIO 585. Cooperative Education Experience. 6 units**

Term Typically Offered: F,W,SP,SU

CR/NC

Prerequisite: Graduate standing in Biological Sciences and consent of instructor.

Advanced study, analysis and part-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Total credit limited to 6 units. Credit/No Credit grading only.

**BIO 590. Seminar in Biology. 1-2 units**

Term Typically Offered: F, W, SP

Prerequisite: Graduate standing in Biological Sciences or consent of instructor.

Critical evaluation of primary literature on a specific topic in biology. Includes oral and/or written presentation of critiques. The Class Schedule will list topic selected. Total credit limited to 12 units. 1 to 2 seminars.

**BIO 591. Biology Colloquium. 1 unit**

Term Typically Offered: F, W, SP

Prerequisite: Graduate standing in Biological Sciences.

Recent trends in the field of biology for graduate students in the Biological Sciences master's degree program. Overview of current research with presentations from visiting scholars and Cal Poly faculty. Total credit limited to 4 units. 1 activity.

**BIO 593. Regenerative Medicine Internship. 3-5 units**

Term Typically Offered: F, W, SP

Prerequisite: Graduate standing in the Specialization in Regenerative Medicine for the MS in Biological Sciences; or the Specialization in Regenerative Medicine for the MS in Biomedical Engineering; or the Specialization in Animal Science for the MS in Agriculture.

Supervised graduate research and/or development in stem cell science or regenerative medicine and engineering. Provides students with an off-campus industrial or university internship. Total credit limited to 10 units. Crosslisted as ASCI/BIO/BMED 593.

**BIO 595. Cooperative Education Experience. 12 units**

Term Typically Offered: F,W,SP,SU

CR/NC

Prerequisite: Graduate standing in Biological Sciences and consent of instructor.

Advanced study, analysis and full-time work experience in student's career field; current innovations, practices, and problems in administration, supervision, and organization of business, industry, and government. Must have demonstrated ability to do independent work and research in career field. Total credit limited to 12 units. Credit/No Credit grading only.

**BIO 599. Thesis. 1-3 units**

Term Typically Offered: F,W,SP,SU

Prerequisite: Graduate standing in Biological Sciences and consent of instructor.

Individual research under the general supervision of the faculty, leading to a graduate thesis of suitable quality. Total credit limited to 9 units.

**BOT Courses****BOT 121. General Botany. 4 units**

Term Typically Offered: F, W, SP

2020-21 or later catalog: GE Area B2

2020-21 or later catalog: GE Area B3

2019-20 or earlier catalog: GE Area B2

2019-20 or earlier catalog: GE Area B4

The anatomy, morphology, physiology, reproduction, diversity, and importance of plants. 3 lectures, 1 laboratory. Fulfills GE Areas B2 and B3 (GE Areas B2 and B4 for students on the 2019-20 or earlier catalogs).

**BOT 311. Plants, People and Civilization. 4 units**

Term Typically Offered: F

2020-21 or later: Upper-Div GE Area B

2019-20 or earlier catalog: GE Area B5, B6, or B7

Sustainability Focused

Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; and one course in GE Area B4 with a grade of C- or better (GE Area B1 for students on the 2019-20 or earlier catalogs); and one of the following courses: BIO 114, BIO 160, BIO 162 or BOT 121.

Human uses of plants for food, beverage, medicine, fiber, recreation, and rituals. Uses of plants by different cultures throughout the world and the social, economical, and environmental importance of plants in our lives. Field trip required. 3 lectures, 1 laboratory. Fulfills GE Area Upper-Division B (GE Areas B5, B6, or B7 for students on the 2019-20 catalog).

**BOT 313. Taxonomy of Vascular Plants. 4 units**

Term Typically Offered: W

Prerequisite: BIO 114 or BIO 162 or BOT 121.

Introduction to classification and identification of vascular plants, emphasizing major plant families; field and herbarium techniques. 2 lectures, 2 laboratories.

**BOT 323. Plant Pathology. 4 units**

Term Typically Offered: F, W, SP

Prerequisite: BIO 162 or BOT 121.

Comprehensive study of the causes and effects of diseases of plants. Designed to lead to an understanding of plant pathology, and modern methods to control plant disease. 2 lectures, 2 activities. Crosslisted as BOT/PLSC 323. Formerly AEPS/BOT 323.

**BOT 326. Plant Ecology. 4 units**

Term Typically Offered: SP

Prerequisite: BIO 114, BIO 162, BIO 211, or BOT 121. Recommended: BIO 263 and STAT 217 or STAT 218.

Plant communities, population dynamics, and effects of the following environmental factors on plant growth and development: soil, water, temperature, light, atmosphere, topography, organisms, and fire. 3 lectures, 1 laboratory.

**BOT 433. Field Botany: California Plant Diversity. 5 units**

Term Typically Offered: SP

Prerequisite: BOT 313, or graduate standing in Biological Sciences.

Field studies of California's diverse vegetation. Identification of plants and plant communities in the field. Factors affecting distribution and ecological relationships. California geography, geology, and evolution of California flora. Several one day field trips and three weekend trips to California's deserts and mountains. Field trips required. 3 lectures, 2 laboratories.

**MCRO Courses****MCRO 100. Introduction to Microbiology Research. 2 units**

Term Typically Offered: W

CR/NC

Group research experience in microbiology through participation in a faculty-student research project. Foundations of the scientific method including literature review, design of experiments, common laboratory techniques, data analysis, interpretation of results and scientific communication. Intended for freshmen and sophomores with no research experience. Priority to MCRO majors. Credit/No Credit grading only. 1 seminar, 1 laboratory.

**MCRO 221. Microbiology. 4 units**

Term Typically Offered: F,W,SP,SU

2020-21 or later catalog: GE Area B2

2020-21 or later catalog: GE Area B3

2019-20 or earlier catalog: GE Area B2

2019-20 or earlier catalog: GE Area B4

Prerequisite: CHEM 110 or CHEM 124 or CHEM 127.

Microbial classification and identification, cell structure and function, metabolism, microbial systems and evolutionary processes, with applications to industry, agriculture, food production, environment, and health. Not open to students with credit in MCRO 224; not for credit for Biology and Microbiology majors. 3 lectures, 1 laboratory. Fulfills GE Areas B2 and B3 (GE Areas B2 and B4 for students on the 2019-20 or earlier catalogs).

**MCRO 224. General Microbiology I. 5 units**

Term Typically Offered: F, W, SP

2020-21 or later catalog: GE Area B2

2020-21 or later catalog: GE Area B3

2019-20 or earlier catalog: GE Area B2

2019-20 or earlier catalog: GE Area B4

Prerequisite: BIO 161; and CHEM 125 or CHEM 128. Recommended: CHEM 129.

Fundamental concepts of prokaryotes, eukaryotic microorganisms and microbiological entities. Microbial taxonomy, classification, cellular structure and function, metabolism, growth dynamics and control. Introduction to microbial genetics and molecular techniques. Microbial interaction with human and society. Fundamental laboratory techniques in microbiology. 3 lectures, 2 laboratories. Fulfills GE Areas B2 and B3 (GE Areas B2 and B4 for students on the 2019-20 or earlier catalogs).

**MCRO 225. General Microbiology II. 5 units**

Term Typically Offered: SP

Prerequisite: MCRO 224.

Microbial diversity, systematics, ecology, and symbiotic relationships. Introduction to host-microorganism interactions including pathogenesis, epidemiology, and immunology. 3 lectures, 2 laboratories.



**MCRO 301. Wine Microbiology. 4 units**

Term Typically Offered: SP

Prerequisite: MCRO majors must have MCRO 224; WVIT majors must have MCRO 221 or MCRO 224; and WVIT 202; open to MCRO or WVIT majors only.

Wine yeasts, bacteria, and molds: morphology and methods of identification; successful alcoholic and malolactic fermentations; management and prevention of unwanted microbial growth; microorganisms and flavor development. 3 lectures, 1 laboratory. Crosslisted as MCRO/WVIT 301.

**MCRO 320. Emerging Infectious Diseases. 3 units**

Term Typically Offered: F,W,SP,SU

Prerequisite: BIO 161; and MCRO 221 or MCRO 224.

Recent outbreaks of human diseases, interrelationships between infectious disease agents, human biology, and the environment. Infectious agents and disease processes, virulence mechanisms, and host immune response. Clinical approaches and surveillance methods to detect, investigate, and monitor emerging pathogens. Factors involved in the accelerating emergence of diseases and bioterrorist agents. 3 lectures.

**MCRO 342. Public Health Microbiology. 4 units**

Term Typically Offered: W, SP

Prerequisite: MCRO 221 or MCRO 224.

Principles of disease prevention and control. Water-, food-, and air-borne microbial contaminations and epidemiology of ensuing diseases. 3 lectures, 1 laboratory.

**MCRO 402. General Virology. 4 units**

Term Typically Offered: W

Prerequisite: BIO 351 or CHEM 373, or graduate standing in Biological Sciences. Recommended: BIO 452.

Infective macromolecules (prions, viroids, and viruses) associated with microbes, plants, and animals. Epidemiology, immune responses, pathogenicity, carcinogenesis, diagnoses, vaccination, and therapy. 3 lectures, 1 laboratory.

**MCRO 421. Food Microbiology. 4 units**

Term Typically Offered: F, SP

Prerequisite: MCRO 221 or MCRO 224. Recommended: CHEM 212/312.

Physiological activities of microorganisms involved in the preparation, preservation, deterioration, and toxicity of foods and related products. Detection and prevention of spoilage microorganisms and foodborne pathogens. 3 lectures, 1 laboratory.

**MCRO 423. Medical Microbiology. 5 units**

Term Typically Offered: F

Prerequisite: Junior standing; MCRO 225; and CHEM 216, CHEM 312 or CHEM 316; and consent of instructor.

Microorganisms as agents of disease in humans. Epidemiology, host-parasite relationships, and chemotherapy. The compromised host and opportunistic disease. Laboratory safety. Procedures for laboratory diagnosis of human diseases. Rapid miniaturized methods of identification. 3 lectures, 2 laboratories.

**MCRO 424. Microbial Physiology. 5 units**

Term Typically Offered: W

Prerequisite: MCRO 225 and CHEM 313 or CHEM 371, or graduate standing in Biological Sciences.

Cellular structure and life processes of bacteria; chemical composition, growth, and metabolism. General biological and evolutionary considerations. 3 lectures, 2 laboratories.

**MCRO 433. Microbial Biotechnology. 3 units**

Term Typically Offered: F

Prerequisite: MCRO 221 or MCRO 224; and BIO 303 or BIO 351 or equivalent; and CHEM 216, CHEM 312 or CHEM 316 or equivalent, or graduate standing in Biological Sciences.

Principles and methods used for production of enzymes, pharmaceuticals, chemicals, and food additives using micro-organisms. Topics include screening and strain improvement, regulation of metabolite production, genetic engineering, heterologous gene expression systems, large-scale production, and intellectual property. 3 lectures.

**MCRO 436. Microbial Ecology. 4 units**

Term Typically Offered: SP

Prerequisite: BIO 160; BIO 161; BIO 263; and MCRO 221 or MCRO 224; or graduate standing in Biological Sciences.

Ecology and interactions of microorganisms in natural environments. Role of microorganisms in ecosystem function such as nutrient cycling, extreme environments, symbioses. Applications of microorganisms in the environment such as bioremediation, biocontrol, biofuels. Field trip may be required. 2 lectures, 2 activities.

**MSCI Courses****MSCI 100. Orientation to Marine Sciences. 1 unit**

Term Typically Offered: F

CR/NC

Prerequisite: Marine Sciences major.

Introduction to Marine Sciences faculty, the Biology Department and campus resources, research opportunities, possible careers, studying science, and current topics in marine sciences. Credit/No credit grading only. 1 lecture.

**MSCI 111. Survey of Marine Biology. 4 units**

Term Typically Offered: W

2020-21 or later catalog: GE Area B2

2019-20 or earlier catalog: GE Area B2

Sustainability Focused

Marine organisms and their adaptations to the ocean. Focus on select marine ecosystems including coastal ecosystems. Interaction between humans and the sea. Topics include effects of ocean acidification and pollution, climate change, and loss of marine biodiversity. Not open for major credit in Biological Sciences, Marine Sciences, or Microbiology. 4 lectures. Fulfills GE Area B2.

**MSCI 300. Marine Ecology. 4 units**

Term Typically Offered: F, W

Prerequisite: BIO 160, BIO 162, and BIO 263. Recommended: STAT 218.

Introduction to the functional biology of marine plants and animals and the ecological processes that underlie their distribution and abundance in open oceans, coastal regions, and estuaries. Field trips required. 2 lectures, 2 laboratories. Formerly MSCI 328.

**MSCI 301. Biological Oceanography. 3 units**

Term Typically Offered: F

Prerequisite: BIO 160; BIO 161; BIO 263; CHEM 129; MSCI 300; PSC 201; and STAT 218.

Interdisciplinary study of marine organisms, how they interact with each other and their physical, chemical and geological environment. Emphasis on how these interactions impact abundance, diversity and temporal and spatial distributions. 3 lectures.

**MSCI 324. Marine Mammals, Birds and Reptiles. 4 units**

Term Typically Offered: W

Prerequisite: BIO 162; BIO 263; and STAT 218.

Introduction to the biology, ecology and evolution of mammals, reptiles and birds of the marine environment, with an emphasis on Central California species, diversity patterns, evolutionary relationships, adaptations to the ocean, and conservation issues. Field trips required. 2 lectures, 2 laboratories.

**MSCI 330. Technologies for Ocean Discovery. 4 units**

Term Typically Offered: SP

2020-21 or later: Upper-Div GE Area B

2019-20 or earlier catalog: GE Area B5, B6, or B7

Prerequisite: Junior standing; completion of GE Area A with grades of C- or better; and completion of GE Areas B1 through B4, with a grade of C- or better in one course in GE Area B4 (GE Area B1 for students on the 2019-20 or earlier catalogs). Recommended: Introductory statistics course.

Survey of ocean sensor systems and emerging technologies that provide new understanding of the ocean. Current issues in marine science. Social context, societal implications of discoveries in ocean sciences. Field trip required. Not open for major credit in Biological Sciences, Marine Sciences or Microbiology. Not open to students with credit in MSCI 403. 3 lectures, 1 activity. Fulfills GE Area Upper-Division B (GE Areas B5, B6, or B7 for students on the 2019-20 catalog).

**MSCI 401. Marine Science Outreach. 1-2 units**

Term Typically Offered: F, W, SP

CR/NC

Prerequisite: MSCI 300 or MSCI 301 or PSC 201; Junior standing and consent of instructor.

Volunteer or internship experience in a marine science business, industry, government agency or informal science center. Positions require communicating science to the public. Formal report and evaluation by work supervisor required. Major credit limited to 4 units. Total credit limited to 8 units. Credit/No credit grading only.

**MSCI 403. Ocean Sampling Techniques. 4 units**

Term Typically Offered: F

Prerequisite: CHEM 302; MSCI 301; PSC 201; and STAT 218.

Introduction to techniques in oceanography and marine sciences. Hands-on technical training in sampling, measuring, tagging and tracking of bathymetry and geography; waves, tides and currents; salinity, temperature and pressure; dissolved oxygen and pH; irradiance and light scattering; phytoplankton and zooplankton; and benthic fauna and marine macrofauna. 2 lectures, 2 laboratories. Formerly MSCI 303.

**MSCI 410. Scientific Diving. 3 units**

Term Typically Offered: SU

Prerequisite: BIO 263, open water diving certificate, and instructor consent. Recommended: MSCI 300 or MSCI 301.

Advanced training in scientific methods associated with practical training in scuba diving. Satisfies American Academy of Underwater Sciences standards. Combination of theory, techniques and scuba diving. Experience collecting data and handling scientific equipment underwater. AAUS certification will require additional assessments outside of class. Field trips and additional fee required. 1 lecture, 2 labs.

**MSCI 428. Marine Conservation and Policy. 4 units**

Term Typically Offered: W

Sustainability Focused

Prerequisite: BIO 160 and BIO 263; and BIO 327 or BIO 363 or BIO 401 or BOT 326 or MSCI 300; or Graduate standing in Biological Sciences. Recommended: PSC 201.

Examination of how science and policy are used to evaluate and implement marine conservation and resource management. Topics include endangered species, fisheries, climate change, marine protected areas, research and conservation topics and developing policy for management decision-making. Field trip required. 3 lectures, 1 laboratory.

**MSCI 437. Marine Botany. 4 units**

Term Typically Offered: W

Prerequisite: Junior standing and BIO 162.

Comprehensive examination of the ecology, life histories, functional morphology, physiology, and taxonomy of marine algae and marine plants. Laboratory emphasizes species endemic to the central coast of California. Course offered in hybrid format with classroom-based and online learning. 3 lectures, 1 laboratory.

**MSCI 438. Aquaculture. 4 units**

Term Typically Offered: F

Prerequisite: BIO 160, BIO 162, and BIO 263.

Propagation and rearing of fishes, invertebrates and algae from marine, freshwater, and estuarine habitats. Current methodologies and general life histories. Global perspective including aquacultural development in developed and developing countries. 3 lectures, 1 laboratory.

**MSCI 439. Fisheries Science and Resource Management. 4 units**

Term Typically Offered: SP

Sustainability Focused

Prerequisite: BIO 162 and MSCI 300. Recommended: BIO 322.

Scientific investigation of marine and freshwater fisheries. Methodologies and quantitative strategies for study of finfish and invertebrates. Role of oceanographic or limnological processes on stock maintenance. Impact of human exploitation on maintenance of sustainable yields, including user-group conflict issues, and regional/global controversies. Lab/field protocols, basic fisheries statistical procedures, molecular methods, computer simulations. Field trip required. 3 lectures, 1 laboratory.

**MSCI 440. Communicating Ocean Sciences to Informal Audiences. 3 units**

Term Typically Offered: F

Prerequisite: Junior standing; BIO 322, BIO 336, MSCI 300, or PSC 201; completion of GE Area A with grades of C- or better; and GE Area B2 or BIO 211.

Simultaneous focus on developing a knowledge of ocean sciences and the advanced educational approaches for communicating that knowledge. Teaching skills developed through coursework, outreach events and design of collaborative projects at museums and aquariums. Primary objective is to learn how to present ocean-themed hands-on, inquiry-based science exhibits, in order to improve the scientific literacy of audiences of all ages. Field trip required. 1 lecture, 2 activities.