

# BIOLOGY

## College of Science and Engineering

Dean: Dr. Carmen Domingo

### Department of Biology

Hensill Hall 538

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Website: [biology.sfsu.edu](http://biology.sfsu.edu) (<http://biology.sfsu.edu>)

Chair: Dr. Vance Vredenburg

Graduate Coordinator: Diana Chu

Graduate Advisors:

Cell and Molecular Biology: D. Chu

Integrative Biology: A. Zink

Physiology and Behavioral Biology: M. Fuse

Biomedical Science: L. Chen

### Program Scope

The Department of Biology provides undergraduate and graduate programs covering the breadth of biology. Course work ranges from introductory biology to specialized courses in broad disciplines of biology. The department has grouped courses into concentrations to help advise students of appropriate programs of study in various biology disciplines. Each concentration provides a breadth of background in basic biological concepts as well as depth in the specific discipline. Students should consult with an advisor early in their program of study to design an individualized program within the concentration of interest. Lists of advisors are available from the department office and website, [biology.sfsu.edu](http://biology.sfsu.edu) (<http://biology.sfsu.edu>).

Students are responsible for information posted on the department website ([biology.sfsu.edu](http://biology.sfsu.edu) (<http://biology.sfsu.edu>)) and in a weekly e-mail bulletin, which declared majors receive, as well as for complying with University, college, and department requirements.

Graduate degree programs provide advanced coursework, seminar experiences, and require a written thesis or research project. The master's degrees provide substantial educational depth and training, giving the student a sound foundation for employment or study in doctoral programs.

### Research Facilities

- State-of-the-Art Greenhouse
- Harry D. Thiers Herbarium
- Genomics and Transcriptions Analysis Center (GTAC)
- Molecular Genetics Laboratory (MGLab), Electron Microscope Facility
- Cell and Molecular Imaging Center (CMIC)
- Estuary and Ocean Science Center (EOS Center)
- Sierra Nevada Field Campus
- Moss Landing Marine Laboratories

### Collaborative Programs

#### Estuary and Ocean Science Center

Opportunities for graduate and undergraduate study in marine sciences are enhanced by specialized aquatic and marine research facilities at the Estuary and Ocean Science Center (EOS Center) on the Romberg Tiburon Campus (RTC). The EOS Center is SF State's marine laboratory on San Francisco Bay, just 11 miles north in Tiburon, CA. The EOS Center

supports: flow-through bay water tanks and tables; a research pier and nearby moorings equipped with a variety of environmental sensors for tracking water quality, weather conditions, and underwater sounds; laboratories for elemental analysis and analysis of water samples for nutrients and carbonate chemistry; specialized microscopes for quantifying, identifying, and visualizing plankton; a molecular genetics laboratory; a greenhouse for raising wetland plants; and a well-equipped, 38-foot research vessel (R/V Questuary) and a small boat fleet to support aquatic field research. The center also offers a motorboat operators training course and supports an active scientific diving program for faculty, staff, and students. Faculty and research scientists from a variety of departments in the College of Science and Engineering offer courses and mentored research opportunities in marine and estuarine sciences at the EOS Center and on the main campus. The EOS Center hosts and administers the Masters of Science in Interdisciplinary Marine and Estuarine Sciences (IMES). Additional research and educational opportunities are available through the SF Bay National Estuarine Research Reserve and the Smithsonian Environmental Research Center programs based at the EOS Center. See [eoscenter.sfsu.edu](http://eoscenter.sfsu.edu) (<http://eoscenter.sfsu.edu>) for more information.

### California Academy of Sciences

The Department of Biology and the California Academy of Sciences (CalAcademy) have instituted a program that builds on the complementary strengths of each institution to address the national and international imperative of training biologists in systematics, ecology, and conservation biology. Curators from CalAcademy who have joined the department as research professors contribute to the teaching program, offer seminars and other courses at CalAcademy and supervise graduate student research. The facilities and collections of the Academy are available for selected students pursuing research in the biological sciences.

### Career Outlook

This is an exciting time for graduates with degrees in biology. Breakthroughs in understanding living systems are leading to the development of new career opportunities at a rapid rate. In this regard, the undergraduate degrees can open the door to excellent career opportunities in industry, health care, public agencies, secondary school teaching, academia, and many other areas. Many graduates enter careers in the biotechnology industry, the health professions, and environmental and conservation biology. High-level positions in industry and academia commonly require advanced graduate work. The bachelor of science degrees are designed to give students the training they need to enter doctoral or master's programs in biology and related disciplines. Each year many SF State biology graduates are accepted into doctoral programs across the country. SF State's biology programs also have a strong record of placing students in medical and dental schools.

The San Francisco Bay Area is one of the world's largest centers for the biotechnology industry. The majors in cell and molecular biology and microbiology emphasize the latest cutting-edge technologies to provide students with relevant practical skills. Many companies actively recruit SF State students for positions or internships, and SF State graduates are well represented in many prominent biotechnology companies. Employment opportunities vary from manufacturing to technical research support to biotechnology and pharmaceuticals research management.

Graduates of the M.S. in Biomedical Science program, with advanced interdisciplinary science education, internship experience, and workplace skills training, tend to be employed in biomedical institutes, biotechnology industries, business corporations, government and non-

profit organizations, or continue to other advanced degrees. The long-term career outlook for professional science master's graduates is excellent.

## Professor

Katharyn Boyer (2004), *Professor in Biology*. Ph.D. University of California, Los Angeles.

Jennifer L. Breckler (1986), *Professor in Biology*. Ph.D. University of California, Los Angeles.

Laura W. Burrus (1996), *Professor in Biology*. Ph.D. University of Wisconsin.

Edward Carpenter (2000), *Professor in Biology*. Ph.D. North Carolina State University.

Joseph Chen (2006), *Professor in Biology*. Ph.D. Harvard University.

Lily Chen (1998), *Professor in Biomedical Laboratory Science*. Ph.D. State University of New York, Buffalo.

Diana Chu (2004), *Professor in Biology*. Ph.D. University of California, Los Angeles.

Sarah Cohen (2003), *Professor in Biology*. Ph.D. University of Washington.

Karen Crow-Sanchez (2007), *Professor in Biology*. Ph.D. University of California, Santa Cruz.

José R. De La Torre (2008), *Professor in Biology*. Ph.D. University of California, San Francisco.

Carmen R. Domingo (1997), *Professor in Biology*. Ph.D. University of California, Berkeley.

Michael A. Goldman (1988), *Professor in Biology*. Ph.D. Purdue University.

Zheng-Hui He (1997), *Professor in Biology*. Ph.D. University of Virginia.

Gretchen LeBuhn (2000), *Professor in Biology*. Ph.D. University of California, Santa Barbara.

Leticia M. Marquez-Magana (1994), *Professor in Biology*. Ph.D. University of California, Berkeley.

Christopher Moffatt (1998), *Professor in Biology*. Ph.D. Johns Hopkins University; Postdoctoral Fellow, University of Massachusetts.

Karina J. Nielsen (2014), *Professor in Biology, Director of the Estuary and Ocean Science Center*. Ph.D. Oregon State University.

V. Thomas Parker (1980), *Professor in Biology*. Ph.D. University of California, Santa Barbara.

Robert M. Ramirez (1992), *Professor in Biology*. Ph.D. University of California, Davis.

Barry Samuel Rothman (1986), *Professor in Biology*. Ph.D. California Institute of Technology.

Greg S. Spicer (1996), *Professor in Biology*. Ph.D. University of Chicago.

Jonathon Stillman (2005), *Professor in Biology*. Ph.D. Oregon State University.

Kimberly Tanner (2004), *Professor in Biology*. Ph.D. University of California, San Francisco.

Andrew Zink (2007), *Professor in Biology*. Ph.D. Cornell University.

## Associate Professor

Yee-Hung Mark Chan (2014), *Associate Professor in Biology*. Ph.D. Stanford University.

Robyn Crook (2015), *Associate Professor in Biology*. Ph.D. The Graduate Center, City University of New York.

Wilfred Denetclaw Jr. (2000), *Associate Professor in Biology*. Ph.D. University of California, Berkeley.

Megumi Fuse (2000), *Associate Professor in Biology*. Ph.D. University of Toronto.

Sally Pasion (2000), *Associate Professor in Biology*. Ph.D. University of California, Los Angeles.

Pleuni Pennings (2014), *Associate Professor in Biology*. Ph.D. Ludwig-Maximilians-Universität München.

Blake Riggs (2009), *Associate Professor in Biology*. Ph.D. University of California, Santa Cruz.

Rorianne Rohlf's (2015), *Associate Professor in Biology*. Ph.D. University of Washington.

Scott Roy (2011), *Associate Professor in Biology*. Ph.D. Harvard University.

Ravinder Sehgal (2007), *Associate Professor in Biology*. Ph.D. University of California, San Francisco; Postdoctoral Fellow San Francisco State University; Postdoctoral Fellow University of California, Davis.

Kevin Simonin (2014), *Associate Professor in Biology*. Ph.D. University of California Berkeley.

Andrea Swei (2013), *Associate Professor in Biology*. Ph.D. University of California, Berkeley.

Vance Vredenburg (2007), *Associate Professor in Biology*. Ph.D. University of California, Berkeley.

Steven L. Weinstein (1997), *Associate Professor in Biology*. Ph.D. University of California, San Francisco.

## Assistant Professor

Ivan A. Anastassov (2018), *Assistant Professor in Biology*. M.Phil. (2009), Graduate Center, City University of New York; Ph.D. (2013), Graduate Center and Hunter College, City University of New York.

Derrick Groom (2021), *Assistant Professor in Biology*. Ph.D. University of Toronto.

Jadelys Tonos (2024), *Assistant Professor in Biology*. Ph.D. Rice University.

Nicole Salazar Velmeshev (2018), *Assistant Professor in Biology*. Ph.D. University of Miami.

## Adjunct Professor

Michelle Alegria-Hartman (2004), *Adjunct Professor in Biology*. Ph.D. University of California, Davis.

Hilary Clark (2004), *Adjunct Professor in Biology*. Ph.D. University of California, Berkeley.

Janis Dickinson (2001), *Adjunct Professor in Biology*. Ph.D. Cornell University.

Eugenio Ferrari (2000), *Adjunct Professor in Biology*. Ph.D. University of Pavia (Italy).

Cynthia Gilbert (2004), *Adjunct Professor in Biology*. Ph.D. University of Washington.

Elizabeth Gray (2002), *Adjunct Professor in Biology*. Ph.D. University of Washington.

John Greenleaf (2000), *Adjunct Professor in Biology*. Ph.D. University of Illinois.

David Gutnik (2004), *Adjunct Professor in Biology*. Ph.D. University of Southern California.

Nina Jablonski (1998), *Adjunct Professor in Biology*. Ph.D. University of Washington.

Patrick Kocielek (2001), *Adjunct Professor in Biology*. Ph.D. University of Michigan.

Steven Lee (2000), *Adjunct Professor in Biology*. Ph.D. University of California, Berkeley.

William Lenarz (2000), *Adjunct Professor in Biology*. Ph.D. University of Washington.

Alan Leviton (2001), *Adjunct Professor in Biology*. Ph.D. (1960), Stanford University.

Douglas Long (2001), *Adjunct Professor in Biology*. Ph.D. University of California, Berkeley.

Jerold Lowenstein (2004), *Adjunct Professor in Biology*. M.D. (1953), Columbia College of Physicians and Surgeons.

Michael McGowan (2000), *Adjunct Professor in Biology*. Ph.D. University of Miami.

Cristian Orrego (1993), *Adjunct Professor in Biology*. Ph.D. Brandeis University.

Gordon Parry (2000), *Adjunct Professor in Biology*. Ph.D. (1975), University College London, University of London

Stephen Ralston (2004), *Adjunct Professor in Biology*. Ph.D. University of Washington, Seattle.

Bala Ravikumar (2001), *Adjunct Professor in Biology*. Ph.D. University of Michigan.

Mark Reynolds (2001), *Adjunct Professor in Biology*. Ph.D. University of California, Berkeley.

Will Russell (2004), *Adjunct Professor in Biology*. Ph.D. University of California, Berkeley.

Carol Tang (2001), *Adjunct Professor in Biology*. Ph.D. University of Southern California, Los Angeles.

Tania Weiss (2000), *Adjunct Professor in Biology*. Ph.D. University of Michigan.

## Research Associate Professor

Frank Cipriano (2000), *Research Associate Professor in Biology*. Ph.D. University of Arizona.

## California Academy of Sciences Research Professor

Terry Gosliner (2001), *California Academy of Sciences Research Professor, Adjunct Professor in Biology*. Ph.D. University of New Hampshire.

David H. Kavanaugh (1998), *California Academy of Sciences Research Professor, Adjunct Professor in Biology*. Ph.D. University of Alberta (Canada).

John E. McCosker (1986), *California Academy of Sciences Research Professor, Adjunct Professor in Biology*. Ph.D. Scripps Institution of Oceanography, University of California, San Diego.

Richard Mooi (2001), *California Academy of Sciences Research Professor, Adjunct Professor in Biology*. Ph.D. University of Toronto (Canada).

Peter Roopnarine (2001), *California Academy of Sciences Research Professor, Adjunct Professor in Biology*. Ph.D. University of California, Davis.

Kim Steiner (2001), *California Academy of Sciences Research Professor, Adjunct Professor in Biology*. Ph.D. University of California, Davis.

Gary Williams (2001), *California Academy of Sciences Research Professor, Adjunct Professor in Biology*. Ph.D. University of Cape Town (South Africa).

## Estuary and Ocean Science Center Research Professor

William Cochlan (2000), *Estuary and Ocean Science Center Research Professor, Adjunct Professor in Biology*. Ph.D. University of British Columbia.

Richard Dugdale (2000), *Estuary and Ocean Science Center Research Professor, Adjunct Professor in Biology*. Ph.D. University of Wisconsin.

Matthew Ferner (2012), *Estuary and Ocean Science Center Research Professor, Adjunct Professor in Biology, Research Director for the San Francisco Bay National Estuarine Research Reserve*. Ph.D. Georgia Institute of Technology.

William J. Kimmerer (1991), *Estuary and Ocean Science Center Research Professor, Adjunct Professor in Biology*. Ph.D. University of Hawaii.

Michael Vasey (2014), *Estuary and Ocean Science Center Research Professor, Adjunct Professor in Biology*. Ph.D. University of California, Santa Cruz.

Frances Wilkerson (2000), *Estuary and Ocean Science Center Research Professor, Adjunct Professor in Biology*. Ph.D. University of Bristol.

## Majors

- Bachelor of Arts in Biology, General (<http://bulletin.sfsu.edu/colleges/science-engineering/biology/ba-general-biology/>)

- Bachelor of Science in Biology: Concentration in Cell and Molecular Biology (<http://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-cell-molecular-biology/>)
- Bachelor of Science in Biology: Concentration in Ecology, Evolution, and Conservation Biology (<http://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-ecology-evolution-conservation-biology/>)
- Bachelor of Science in Biology: Concentration in Marine Science (<http://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-marine-science/>)
- Bachelor of Science in Biology: Concentration in Microbiology (<http://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-microbiology/>)
- Bachelor of Science in Biology: Concentration in Physiology (<http://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-physiology/>)

## Minor

- Minor in General Biology (<http://bulletin.sfsu.edu/colleges/science-engineering/biology/minor-general-biology/>)

## Masters

- Master of Science in Biology: Concentration in Cell and Molecular Biology (<http://bulletin.sfsu.edu/colleges/science-engineering/biology/ms-biology-concentration-cell-molecular-biology/>)
- Master of Science in Biology: Concentration in Integrative Biology (<http://bulletin.sfsu.edu/colleges/science-engineering/biology/ms-biology-concentration-eeeb/>)
- Master of Science in Biology: Concentration in Physiology and Behavioral Biology (<http://bulletin.sfsu.edu/colleges/science-engineering/biology/ms-biology-concentration-physiology-behavioral-biology/>)
- Master of Science in Biomedical Science: Concentration in Biotechnology (<http://bulletin.sfsu.edu/colleges/science-engineering/biology/ms-biomedical-science-concentration-biotechnology/>)
- Master of Science in Biomedical Science: Concentration in Stem Cell Science (<http://bulletin.sfsu.edu/colleges/science-engineering/biology/ms-biomedical-science-concentration-stem-cell-science/>)

### BIOL 100 Human Biology (Units: 3)

Principles of human biology including body structure and function, reproduction, development, heredity, and evolution. Aspects of modern biology impacting the human species. Intended for non-Biology majors.

#### Course Attributes:

- E1 LLD Pre-Fall 2019
- B2: Life Science

### BIOL 101 Human Biology Laboratory (Unit: 1)

Prerequisite: BIOL 100\* (may be taken concurrently).

Laboratory exercises demonstrating scientific processes, including the scientific method, analysis of data, and drawing appropriate conclusions. Extra fee required.

#### Course Attributes:

- B3: Lab Science

### BIOL 150 The World of Plants (Units: 3)

World of plants, their place in nature, and their relationship to humans. Growing plants, field observations, and studies of the economic uses of plants. Intended for non-Biology majors. Lecture, 2 units; laboratory, 1 unit. Extra fee required.

#### Course Attributes:

- B2: Life Science
- B3: Lab Science
- Environmental Sustainability

### BIOL 160 Marine Biology (Units: 3)

Introduction to the marine environment including oceanic, intertidal, and nearshore communities of plants, animals, and microbes. Emphasis on marine biological and chemical processes and environmental issues both locally and globally.

#### Course Attributes:

- B2: Life Science
- Environmental Sustainability

### BIOL 161 Climate Change and the Oceans (Units: 3)

The world's oceans have absorbed roughly 90% of the Earth's excess heat from global warming and annually absorb one-third of fossil fuel produced CO<sub>2</sub>, which has a huge impact on the world's oceans that are so important as a global food resource. Examine the politics of climate change, and the ocean's effects on weather, commerce, and humanity.

### BIOL 170 Animal Diversity (Units: 3)

Describes the diversity of animal life and provides an overview of basic concepts of evolution, the fossil record, physiology, behavior, ecology, geographical distribution, and issues in the conservation of biodiversity. Intended for non-Biology majors.

#### Course Attributes:

- B2: Life Science
- Environmental Sustainability

### BIOL 210 General Microbiology and Public Health (Units: 3)

Basic concepts of microbiology including practical applications to medicine, public health, and the environment. Intended for non-Biology majors.

### BIOL 211 General Microbiology and Public Health Laboratory (Unit: 1)

Prerequisite: BIOL 210\* (may be taken concurrently).

Laboratory techniques in isolation, enumeration, and identification of microorganisms. Laboratory. Extra fee required. Intended for non-Biology majors.

### BIOL 212 Principles of Human Physiology (Units: 3)

Prerequisites: CHEM 101\* or CHEM 115\*; BIOL 100\* and BIOL 101\*, or BIOL 210\*, all with grades of C or better.

Physiology of human organ systems and principles of homeostasis. Intended for non-Biology majors.

### BIOL 213 Principles of Human Physiology Laboratory (Unit: 1)

Prerequisite: BIOL 212\* (may be taken concurrently).

Laboratory exercises in mammalian physiology. To accompany or follow BIOL 212. Extra lab fee required.

**BIOL 220 Principles of Human Anatomy (Units: 4)**

Prerequisites: BIOL 100\* and BIOL 101\*, or BIOL 212\* and BIOL 213\*.

Study of the gross anatomy of the human body including body systems involving gross structure and history. Computerized virtual anatomy lab experience supplemented with enhanced skeletal and specimen study and cadaver visits. (Plus-minus letter grade only)

**BIOL 230 Introductory Biology I (Units: 5)**

Prerequisites: Restricted to Biology and Biochemistry majors and minors, Kinesiology majors, and Environmental Studies: Natural Resources Management and Conservation majors.

Fundamentals of biology including chemical basis of life, cell structure, bioenergetics, plant and animal physiology, and genetics. Lecture, 3 units; laboratory, 2 units. Extra fee required.

**BIOL 231 Advising for Success as a Biology Major (Unit: 1)**

Prerequisite: Restricted to Biology majors.

Introduction to the resources and opportunities available to Biology majors at SF State. Includes meeting with advisors, peer mentors, and instructors to explore what resources are available to achieve learning goals and develop a cohesive plan for completing Biology degrees. (Plus-minus letter grade only)

**BIOL 240 Introductory Biology II (Units: 5)**

Prerequisite: BIOL 230\* with a grade of C- or better.

Fundamentals of biology including gene expression, development, evolution, ecology, and the diversity of microbes, plants, and animals. Lecture, 3 units; laboratory, 1 unit; seminar, 1 unit. Extra fee required.

**BIOL 300 Nature Study (Units: 3)**

Prerequisites: GE Areas A1\*, A2\*, A3\*, and B4\* all with grades of C- or better; a college-level biology course\*; or permission of the instructor.

Explore the identification, structure, adaptation, life history, habits, habitat, economic status, and conservation of common plants and animals. Includes two all-day field trips scheduled on two separate weekends. Intended for non-Biology majors. Lecture, 2 units; laboratory, 1 unit. Extra fee required.

**Course Attributes:**

- UD-B: Physical Life Science
- Environmental Sustainability

**BIOL 305 Global Politics of Science, Technology, and Health (Units: 4)**

Prerequisites: GE Areas A1\*, A2\*, A3\*, and B4\* all with grades of C- or better; I R 104 or equivalent; or permission of the instructor.

Examine the cultural, ethical, economic, and political dimensions of science, technology, and health in a global context. Explore how science, technology, and public health both shape politics and are shaped by politics. Consider the role of science in government and society; the dilemmas of international organizations and scientific knowledge; technology and big tech companies in international relations, science and technology policy, and government regulation; global health regimes and institutions; and the implications of social media, artificial intelligence, and cyber-currencies.

(This course is offered as I R 305 and BIOL 305. Students may not repeat the course under an alternate prefix.)

**Course Attributes:**

- UD-D: Social Sciences
- Environmental Sustainability
- Global Perspectives

**BIOL 310 Biology for Today's World (Units: 3)**

Prerequisites: GE Areas A1\*, A2\*, A3\*, and B4\* all with grades of C- or better; one college-level biology course\*; or permission of the instructor.

Fundamental concepts and processes in genetics, cell biology, evolution, ecology, and biodiversity. Scientific inquiry. Application of concepts to current issues in science and society. Lecture, 2 units; activity, 1 unit.

**Course Attributes:**

- UD-B: Physical Life Science
- Environmental Sustainability

**BIOL 313 Principles of Ecology (Units: 3)**

Prerequisite: One college-level biology or environmentally-oriented course. Intended for non-Biology majors.

Ecological principles and methods. Introduction to population, community, and ecosystem ecology. Includes trips to various habitats. Lecture, 2 units; laboratory, 1 unit. Extra fee required.

**BIOL 315 Field Methods in Ecology and Evolution (Unit: 1)**

Prerequisite for BIOL 715: Graduate standing or permission of the instructor.

Prerequisites for BIOL 315: Restricted to upper-division standing; BIOL 240\* and BIOL 458\* with grades of C or better; GPA of 3.0 or better; or permission of the instructor.

An introduction to sampling and experimental design for environmental biologists. An overview of methods for sampling a variety of organisms in specific habitats. Principles of design, execution, and interpretation of data derived from field experiments will be explored. Data analysis and visualization will be emphasized.

(BIOL 315/BIOL 715 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 317 Ecology of California (Units: 3)**

Prerequisite: A college-level biology course.

Examines the ecology and natural history of California, and the impact humans have on the environment in perceptual and scientific content. Focus on the principal processes underlying the evolution/diversity of California's terrestrial/aquatic flora/fauna.

**BIOL 318 Our Endangered Planet (Units: 3)**

Prerequisites: GE Areas A1\*, A2\*, A3\*, and B4\* all with grades of C- or better; one college-level biology course\*; or permission of the instructor.

The effect of humans on the ecology of our environment. Species extinctions, the role of genetics, nature reserves, the biology of small populations, and restoration ecology. Intended for non-Biology majors.

**Course Attributes:**

- E1 LLD Pre-Fall 2019
- UD-B: Physical Life Science
- Am. Ethnic & Racial Minorities
- Environmental Sustainability
- Global Perspectives

**BIOL 326 Disease! (Units: 3)**

Prerequisites: GE Areas A1\*, A2\*, A3\*, and B4\* all with grades of C- or better; BIOL 100 or equivalent\*; or permission of the instructor.

Origin and natural history of selected infectious and non-infectious human diseases, including causal agents, mechanisms, and historical impact. Factors involved in the incidence and distribution of disease. Intended for non-Biology majors.

**Course Attributes:**

- UD-B: Physical Life Science
- Global Perspectives

**BIOL 327 HIV, AIDS, and the Science to End the Epidemic (Units: 3)**

Prerequisites: GE Areas A1\*, A2\*, A3\*, and B4\* all with grades of C- or better; one college-level Biology course\*; or permission of the instructor.

Track one of the few modern epidemics to understand how it came about and analyze what was effective in combating the epidemic, what was less effective, and the lessons that can be learned for this disease and others.

**Course Attributes:**

- UD-B: Physical Life Science
- Global Perspectives

**BIOL 328 Human Anatomy (Units: 4)**

Prerequisites: Restricted to Biology, Biochemistry, Chemistry, Clinical Science, and Kinesiology majors with sophomore standing or above; BIOL 230\* with a grade of C- or better; or permission of the instructor.

Gross structures of the human body. Lecture, 3 units; laboratory, 1 unit. Extra fee required.

**BIOL 330 Human Sexuality (Units: 3)**

Prerequisites: GE Areas A1\*, A2\*, A3\*, and B4\* all with grades of C- or better; one college-level Biology course\*; or permission of the instructor.

Development, structure, function, and dysfunction of reproductive and sexual systems in humans, physiology of sexual response, variations in sexual expression, law, birth control and abortion, sexual health, sexual motivation, love, and sexual values. Intended for B.A. in General Biology and non-Biology majors.

**Course Attributes:**

- E1 LLD Pre-Fall 2019
- UD-B: Physical Life Science

**BIOL 331 Research with Communities (Units: 3)**

Prerequisites: Restricted to upper-division standing; BIOL 100 or BIOL 230; or permission of the instructor.

Application of research justice and community-engaged research to CSL. Activities will include improving the well-being of communities by addressing biological and social determinants of health. These will be examined within the context of racial/ethnic health disparities caused by systemic racism and social disadvantage. Local health disparities will be addressed by honing skills and knowledge to meet the needs of communities of color through direct service, community organizing, and transcreation. Lecture, 2 units; activity, 1 unit. [CSL may be available] (This course is offered as BIOL 331 and RRS 331. Students may not repeat the course under an alternate prefix.)

**BIOL 332 Health Disparities in Cancer (Units: 3)**

Prerequisite for BIOL 832: Graduate standing or permission of the instructor.

Prerequisites for BIOL 332: Restricted to upper-division standing; BIOL 230, BIOL 240, and BIOL 355; GPA of 3.0 or higher; or permission of the instructor.

Major determinants of health disparities in cancer including ethnic differences in biology and prevention and treatment of cancer. Strategies to overcome these disparities through research, health education, outreach, advocacy, and policy changes.

(BIOL 832/BIOL 332 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**Course Attributes:**

- Am. Ethnic & Racial Minorities
- Global Perspectives
- Social Justice

**BIOL 337 Evolution (Units: 3)**

Prerequisites: BIOL 230\*, BIOL 240\*, and BIOL 355\*.

The principles of evolutionary biology, concentrating on basic population genetic mechanisms and methods of analysis. Intended for biology and non-Biology majors.

**BIOL 349 Bioethics (Units: 3)**

Prerequisites: Restricted to upper-division standing; GE Areas A1\*, A2\*, A3\*, and B4\* all with grades of C- or better; or permission of the instructor.

Human experiments, genetic engineering, in-vitro fertilization, human enhancement, cloning, reproductive technology, animal testing, euthanasia, and assisted dying. Emphasis on respectful and reflective discussion.

**Course Attributes:**

- UD-B: Physical Life Science
- Social Justice

**BIOL 350 Cell Biology (Units: 3)**

Prerequisites: Restricted to upper-division standing with BIOL 230\*, BIOL 240\*, and CHEM 115\*; or upper-division Chemistry or Biochemistry majors with BIOL 230\* and either BIOL 240\* or CHEM 340\*; all with grades of C- or better.

Cell structure and function, extracellular matrix interactions, signal transduction, and regulatory mechanisms in cell growth and differentiation.

**BIOL 351GW Experiments in Cell and Molecular Biology - GEAR (Units: 4)**

Prerequisites: Restricted to Biology and Biochemistry majors; upper-division standing; GE Area A2\*, BIOL 350\*, and BIOL 355\*.

Experiments introducing laboratory techniques including microscopy, cytochemistry, spectrophotometric quantitation of macromolecules, organelle isolation, animal cell culture, gene expression, protein analysis, and recombinant DNA techniques. Lecture, 2 units; laboratory, 2 units. Extra fee required. (Plus-minus ABC/NC)

**Course Attributes:**

- Graduation Writing Assessment

**BIOL 355 Genetics (Units: 3)**

Prerequisites: BIOL 230\*, BIOL 240\*, and CHEM 115\*; or Chemistry or Biochemistry majors with BIOL 230\* and either BIOL 240\* or CHEM 340\*, all with grades of C- or better.

Viral, prokaryotic, and eukaryotic genetics. Population, human, and molecular genetics.

**BIOL 356 Honors Genetics (Units: 2)**

Prerequisite: BIOL 355 with a grade of B or better. Intended for Biology majors.

Advanced topics, new ideas, unsolved problems, reading of original research, and review of articles in genetics: Mendelian, molecular, and population. (Plus-minus letter grade only)

**BIOL 357 Molecular Genetics (Units: 3)**

Prerequisite: BIOL 355\* or equivalent with a grade of C- or better.

Current ideas in molecular biology including the transfer and expression of genetic information, interaction and hybridization of genes, molecular mutagens, and molecular evolution. Ethical questions in molecular genetics. Intended for Biology majors.

**BIOL 358 Forensic Genetics: Math Matters (Units: 4)**

Prerequisites: Restricted to Biology, Chemistry, Mathematics, and Computer Science majors with sophomore standing or above; BIOL 230 with a grade of C- or better and MATH 199; or permission of the instructor.

Statistical forensic genetics with a focus on social impact. Statistical exploration and analyses in R programming language. Creation of an original scientific research project. Critical analysis of forensics in the media. Completion of a forensic genetics policy proposal project. Lecture, 3 units; laboratory, 1 unit. (Plus-minus letter only)

**BIOL 360 Cancer Biology (Units: 3)**

Prerequisites for BIOL 760: Graduate standing; coursework in cell or molecular biology; or permission of the instructor.  
Prerequisites for BIOL 360: Upper-division standing; BIOL 350\* and BIOL 355\*; GPA of 3.0 or better, or permission of the instructor.

The molecular and cellular basis of cancer. Emphasis on potential therapeutic targets, including cell cycle regulators, signal transduction mechanisms, cellular differentiation factors, oncogenes, and tumor suppressors. (Plus-minus letter grade only)

(BIOL 760/BIOL 360 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 380 Evolutionary Developmental Biology (Units: 3)**

Prerequisites: BIOL 355\* with a grade of C- or better. BIOL 337 is highly recommended. Intended for Biology majors.

Examine the evolution of animal diversity by evaluating the co-option of developmental mechanisms and comparative embryology from representative taxa spanning ancestral multicellular animals through vertebrates. (Plus-minus letter grade only)

**BIOL 382 Developmental Biology (Units: 3)**

Prerequisites for BIOL 782: Graduate standing; BIOL 350 and BIOL 355 or equivalents with grades of C- or better; or permission of the instructor.  
Prerequisites for BIOL 382: Upper-division standing; BIOL 350 and BIOL 355 with grades of C- or better; GPA of 3.0 or higher; or permission of the instructor. Intended for Biology and Biochemistry majors.

Early embryonic development including the exploration of the molecular genetic basis for tissue differentiation. Gene regulation, chromatin, sex determination, oncogenesis, aging, and pattern formation.  
(BIOL 782/BIOL 382 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 401 General Microbiology (Units: 3)**

Prerequisites: BIOL 230, BIOL 240, and either CHEM 130 or CHEM 233 with grades of C- or better. Intended for Biology and Biochemistry majors.

Morphology, physiology, genetics, molecular biology, evolution, and taxonomy of microorganisms. Bacteria and viruses. The importance of microbes in biotechnology, ecology, and public health.

**BIOL 402GW General Microbiology Laboratory - GEAR (Units: 3)**

Prerequisites: Restricted to Biology majors; GE Area A2; BIOL 401 (may be taken concurrently).

Laboratory techniques in the isolation, cultivation, and identification of microbes, especially bacteria. Microbial properties including nutrition, gene transfer, enzyme induction, and viral replication. Lecture, 1 unit; laboratory, 2 units. Extra fee required. (Plus-minus ABC/NC)

**Course Attributes:**

- Graduation Writing Assessment

**BIOL 411 Environmental Microbiology (Units: 3)**

Prerequisites: BIOL 355, BIOL 401, and BIOL 402GW; CHEM 340 or CHEM 349. Intended for Biology majors.

Study of microbes and microbial communities using molecular and genomic approaches. Primary research data includes novel microbial genomes and metagenomes. (Plus-minus letter grade only)

**BIOL 420 General Virology (Units: 3)**

Prerequisites: BIOL 401 and BIOL 402GW with grades of C- or better; or permission of the instructor. Intended for Biology majors.

Molecular aspects of virus structure, genetics, reproduction, and infection. Virus types include bacterial, animal, and plant. (Plus-minus letter grade only)

**BIOL 425 Emerging Diseases (Units: 3)**

Prerequisites: BIOL 350 or BIOL 355 or BIOL 401; and CHEM 130 or CHEM 233.

Biology of the emerging diseases that threaten humans and wildlife. The molecular biology, genetics, epidemiology, ecology, and economic impact of emerging viruses.

**BIOL 430 Medical Microbiology (Units: 3)**

Prerequisites: Priority enrollment for graduating senior Biology majors and majors requiring this course; BIOL 401 with a grade of C or better; permission of the instructor.

Principles of infection, immunity, and characterization of medically important microbial agents.

**BIOL 431 Medical Microbiology Laboratory (Units: 2)**

Prerequisites: Priority enrollment for B.S. Biology majors; BIOL 401, BIOL 402GW with a grade of C- or better, and BIOL 430 (may be taken concurrently); permission of the instructor.

Basic principles and current standard diagnostic procedures in medical microbiology. Lecture, 1 unit; laboratory, 1 unit. Extra fee required. (Plus-minus letter grade only)

**BIOL 435 Immunology (Units: 3)**

Prerequisite: BIOL 350\* or BIOL 401\*.

Innate and acquired immunity. Recognition of antigens. Mechanisms of immune responses and their induction. Measurement and variations of immunity as in hypersensitivity and immune suppression and their effects on the host. Intended for Biology majors.

**BIOL 436 Immunology Laboratory (Units: 2)**

Prerequisites: BIOL 402GW or equivalent; concurrent enrollment in BIOL 435.

Laboratory illustrating antibody-antigen interactions, the cellular basis of immune responses, and the applications of immune and serological reactions. Extra fee required.

**BIOL 442 Microbial Physiology (Units: 3)**

Prerequisites: BIOL 401, BIOL 402GW with a grade of C- or better, and CHEM 349 or equivalent. Intended for Biology majors.

Function, biosynthesis, structure, and chemistry of cells and viruses. Focus on transport, chemotaxis, and energy metabolism, the regulation of growth rate and growth efficiency, and mechanisms of viral and microbial differentiation.

**BIOL 443 Microbial Physiology Laboratory (Units: 2)**

Prerequisite: BIOL 442 (may be taken concurrently). Intended for Biology majors.

Experiments in the physiology and metabolism of protists and bacteria including growth studies, cell fractionation procedures, enzyme preparations and assays, and analyses of cellular molecules. Incorporates analytical instrumentation and statistical techniques. Extra fee required.

**BIOL 446 Microbial Genomics (Units: 4)**

Prerequisites: BIOL 401, BIOL 402GW, and BIOL 355; permission of the instructor.

Techniques in comparative microbial genomics including a class project in analyzing and annotating a novel microbial genome. (Plus-minus letter grade only)

**BIOL 453 General Parasitology (Units: 3)**

Prerequisites: BIOL 230, BIOL 240, and BIOL 355. Intended for Biology majors.

Biology of animal parasites including parasite structure/function, cellular, immunological, biochemical, and molecular parasitology, and control and prevention. Examination of the impact of parasitic infection on human health, culture, and socio-economic welfare.

**BIOL 454 Parasitology Laboratory (Unit: 1)**

Prerequisite: BIOL 453 (may be taken concurrently).

Methods and techniques in the examination, preparation, recognition, and identification of protozoan and metazoan parasites of animal hosts. Human parasites with an orientation toward clinical science. Extra fee required.

**BIOL 458 Biometry (Units: 4)**

Prerequisite: One college-level Biology course\*.

Biological measurements, experimental design, data analysis, and statistical methods as applied to biological problems and methods of data resolution and presentation. Intended for Biology majors. Lecture, 3 units; laboratory, 1 unit. Extra fee required.

**BIOL 460 General Entomology (Units: 4)**

Prerequisites: BIOL 230 and BIOL 240; or permission of the instructor. Intended for Biology majors.

The insects and their close relatives including physiology, external and internal structures, life cycles, classification of insects to order, ecology in desert, field, forest, and aquatic habitats, and the economic and medical importance of orders. Lecture, 2 units; laboratory, 2 units. Extra fee required.

**BIOL 470 Natural History of Vertebrates (Units: 4)**

Prerequisites: BIOL 230 and BIOL 240. Intended for Biology majors.

Structure, behavior, and distribution of amphibians, reptiles, birds, and mammals, especially those of Central California. One all-day field trip required. Lecture, 2 units; laboratory, 2 units. Extra fee required.

**BIOL 475GW Herpetology - GVAR (Units: 3)**

Prerequisites: GE Area A2; BIOL 230 and BIOL 240; or permission of the instructor. Intended for Biology majors.

Evolution, classification, and distribution of amphibians and reptiles. The ecology and behavior of California species. Lecture, 2 units; laboratory, 1 unit. Extra fee required. (Plus-minus ABC/NC)

**Course Attributes:**

- Graduation Writing Assessment

**BIOL 478GW Ornithology - GVAR (Units: 4)**

Prerequisites: GE Area A2; BIOL 230 and BIOL 240; or permission of the instructor. Intended for Biology majors.

Anatomy, physiology, behavior, distribution, classification, and evolution of birds. Visits to the San Francisco Zoo, private aviaries, and museums. One weekend field trip required. Lecture, 2 units; laboratory, 2 units. Extra fee required. (Plus-minus ABC/NC)

**Course Attributes:**

- Graduation Writing Assessment

**BIOL 482 Ecology (Units: 4)**

Prerequisites: BIOL 230 and BIOL 240. Intended for Biology majors.

Interrelationships between organisms and their environment studied at the individual, population, community, and ecosystem levels. Field trips to various environments. Lecture, 3 units; laboratory, 1 unit. Extra fee required.



**BIOL 490 Ecology of Infectious Diseases (Units: 4)**

Prerequisites: BIOL 230\* and BIOL 240\* with grades of C- or better.

Examination of ecological and evolutionary processes that govern the transmission of pathogens in animal and plant systems, including factors that lead to disease emergence, the impact of diseases on host populations, and theoretical foundations of disease ecology. Experience with developing a research question, formulating a testable hypothesis, biological data collection, quantitative analysis, and written and oral presentations through a group research project to assess ecology and risk of tick-borne diseases in the San Francisco Bay Area. Lecture, 3 units; laboratory, 1 unit.

**BIOL 500 Evolution and Diversity of Plants (Units: 4)**

Prerequisites: BIOL 230 and BIOL 240.

Comparative biology and phylogeny of the major lineages of plants. Evolution and diversification of vegetative and reproductive structures, life histories, and ecological adaptations. Lecture, 2 units; laboratory, 2 units. Extra fee required.

**BIOL 502 Biology of the Algae (Units: 3)**

Prerequisite for BIOL 702: Graduate standing or permission of the instructor.

Prerequisites for BIOL 502: Upper-division standing; BIOL 230 and BIOL 240; GPA of 3.0 or higher; or permission of the instructor. Intended for Biology majors.

Collection, preservation, identification, and culturing of marine and freshwater algae. Comparative studies of morphology, life history, and ecology. Field trips. Seminar, 2 units; laboratory, 1 unit. Extra fee required. (BIOL 702/BIOL 502 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 504 Biology of the Fungi (Units: 4)**

Prerequisites: BIOL 230 and BIOL 240. Intended for Biology majors.

Groups of fungi including their classification, life cycles, morphology and development, and economic significance. Lecture, 2 units; laboratory, 2 units. Extra fee required.

**BIOL 505 Plant Structure and Function (Units: 3)**

Prerequisites: BIOL 230 and BIOL 240. Intended for Biology majors.

Plant cells and tissues, their structure, development, and organization into vegetative and reproductive structures. Evolutionary and ecological interpretation of tissues of vascular plants. Lecture, 2 units; laboratory, 1 unit. Extra fee required.

**BIOL 508 Plants and Human Affairs (Units: 3)**

Prerequisites: BIOL 230 and BIOL 240. Intended for Biology majors.

Plants useful or harmful to humans; origins and history, botanical relationships, chemical constituents that make them economically important, and their roles in literate and preliterate cultures. Lecture, 2 units; laboratory, 1 unit.

**BIOL 514 Plant Biodiversity and California Field Botany (Units: 5)**

Prerequisite for BIOL 814: Graduate standing or permission of the instructor.

Prerequisites for BIOL 514: Upper-division standing; BIOL 230 and BIOL 240\*; GPA of 3.0 or higher; or permission of the instructor.

Examine plant biodiversity through principles of classification, phylogenetic relationships, and global biogeography. Hands-on experience gained through numerous field trips and laboratory exercises with live plant material offers practice in the identification of any plant species, collection of herbarium specimens, and other field botany techniques. Expertise gained of all major native Californian plant lineages and ecosystems, including those used by indigenous peoples. Intended for Biology majors. Lecture, 2 units; laboratory, 3 units. (Plus-minus letter grade only.)

(BIOL 814/BIOL 514 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 525 Plant Physiology (Units: 3)**

Prerequisites: BIOL 230, BIOL 240, and CHEM 130. Intended for Biology majors.

Plant physiology including photosynthesis, water and mineral uptake and distribution, translocation of organic materials. Environmental and internal plant regulatory factors and their effect on growth and metabolism.

**BIOL 526 Plant Molecular Physiology Laboratory (Units: 2)**

Prerequisites: Restricted to Biology majors; BIOL 230, BIOL 240, and CHEM 130.

Molecular, physiological, and biochemical understanding of plant growth and development. Focus on plant development, plant-plant and plant-environment interactions, photosynthesis, water balance, mineral nutrition, gene expression, cell imaging, data analyses, and presentations. Extra fee required.

**BIOL 529GW Plant Ecology - GVAR (Units: 4)**

Prerequisites: GE Area A2; BIOL 230 and BIOL 240; or permission of the instructor. Intended for Biology majors.

Principles of ecology through the study of plants and plant associations. Ecological concepts, biotic-environmental dynamics and relationships, and levels of ecological integration. Biotic provinces and plant associations in California. Lecture, 2 units; laboratory, 2 units. Extra fee required. (Plus-minus ABC/NC)

**Course Attributes:**

- Graduation Writing Assessment

**BIOL 530 Conservation Biology (Units: 3)**

Prerequisites: BIOL 230 and BIOL 240; or permission of the instructor. Intended for Biology majors.

Principles of nature conservation, preservation, and management. Theory, laws, and practice of conservation science.

**BIOL 532 Restoration Ecology (Units: 3)**

Prerequisites: BIOL 230 and BIOL 240.

Focuses on the restoration of degraded habitats with an emphasis on the application of ecological theory to restoration practice. A variety of habitats will be covered especially those common to the Bay Area.

**BIOL 534 Wetland Ecology (Units: 4)**

Prerequisites: BIOL 230, and BIOL 240; or permission of the instructor.

Ecology of a variety of wetland types, biotic and abiotic characteristics and processes, conservation, restoration, and management. Field trips to wetland habitats and participation in field and/or greenhouse experiments. Lecture, 3 units; laboratory, 1 unit. Extra fee required.

**BIOL 555 Marine Invertebrate Zoology (Units: 4)**

Prerequisites: BIOL 230 and BIOL 240. Intended for Biology majors.

Comparative laboratory and field study of local marine invertebrate animals and evolution and functional morphology. Lecture, 2 units; laboratory, 2 units. Extra fee required.

**BIOL 570GW Biology of Fishes - GVAR (Units: 4)**

Prerequisites: GE Area A2, BIOL 230, and BIOL 240; or permission of the instructor. Intended for Biology majors.

Morphology, physiology, behavior, ecology, distribution, classification, and evolution of marine and freshwater fishes with a focus on California species. Two-weekend field trips. Lecture, 2 units; laboratory, 2 units. Extra fee required. (Plus-minus ABC/NC)

**Course Attributes:**

- Graduation Writing Assessment

**BIOL 572 Colloquium in Ecology, Evolution, and Conservation (Units: 2)**

Prerequisite for BIOL 872: Graduate standing.

Prerequisites for BIOL 572: Upper-division standing; GPA of 3.0 or higher; or permission of the instructor.

Presentations of student and faculty research, recent journal articles, and by outside speakers. Student speakers receive graduate seminar credit. May be repeated for a total of 8 units.

(BIOL 872/BIOL 572 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 577 Climate and Ecological Interactions (Units: 4)**

Prerequisites: MATH 107 and MATH 108, or MATH 199, or MATH 226; BIOL 230 and BIOL 240 or two 200-level or higher courses in Earth & Climate Sciences; or permission of the instructor.

Theory, observations, and modeling of the two-way interaction between climate and ecology. Lecture, 3 units; laboratory, 1 unit. (Plus-minus letter grade only)

(This course is offered as BIOL 577 and EARTH 577. Students may not repeat the course under an alternate prefix.)

**BIOL 580 Limnology (Units: 3)**

Prerequisites: BIOL 230, BIOL 240, and CHEM 215; an ecology course is recommended. Intended for Biology majors.

Physical, chemical, and biological characteristics of inland waters. Individual field projects. Field trips conducted during class time. Lecture, 2 units; laboratory, 1 unit. Extra fee required.

**BIOL 582 Biological Oceanography & Limnology (Units: 4)**

Prerequisites: BIOL 230 and BIOL 240. Intended for Biology majors.

Biological, chemical and physical characteristics of Earth's oceans and freshwaters. The biology of plankton, nekton, and benthos, emphasizing production and food webs. Identification, sampling, and productivity measurements of marine organisms. Lecture, 3 units; laboratory, 1 unit. Extra fee required.

**BIOL 585 Marine Ecology (Units: 3)**

Prerequisites: BIOL 230 and BIOL 240. Intended for Biology majors.

Plant and animal relationships in near-shore marine communities and temperate zone communities of the central California coast.

**BIOL 586GW Marine Ecology Laboratory - GVAR (Units: 4)**

Prerequisites: Restricted to upper-division standing; Biology majors; BIOL 230 and BIOL 240; or permission of the instructor.

Laboratory and fieldwork in marine ecology serves as an introduction to hypothesis-driven research, research design, sampling methods, laboratory techniques, data collection, and analysis. Fieldwork in a variety of marine field environments. Includes use of primary literature and oral and written presentations. Lecture: 2 units; laboratory: 2 units. (Plus-minus ABC/NC; CR/NC not allowed) Extra fee required.

**Course Attributes:**

- Graduation Writing Assessment

**BIOL 600 Animal Behavior (Units: 3)**

Prerequisites: BIOL 230\* and BIOL 240\*.

General introduction to animal behavior. Mechanisms of behavior including development, hormones, neural processes, and cognition. Evolutionary approaches including foraging, habitat selection, communication, sexual selection, mating systems, parental care, and social behavior. (Plus-minus letter grade only)

**BIOL 607 Conservation and Management of Marine Mammals (Units: 3)**

Prerequisites: BIOL 230, BIOL 240, and BIOL 355.

Biology and scientific principles involved in the conservation and management of marine mammals. Current regulations and methodologies are critically reviewed and evaluated. Controversies concerning conservation, ecological balance, and specific governmental constraints in the face of a changing environment will be discussed.

**BIOL 609 Physics in Medicine (Units: 3)**

Prerequisites: PHYS 121 and BIOL 230 or equivalents; or permission of the instructor.

Mechanics, thermodynamics, and electricity applied to mechanical properties of tissues, metabolism, membrane transport, control and regulation of physical parameters. Sonography, electromagnetism and quantum physics applied to medical diagnostic technology and imaging.

**BIOL 612 Human Physiology (Units: 3)**

Prerequisites: BIOL 230, BIOL 240, CHEM 130, and PHYS 121; or Chemistry and Biochemistry majors with BIOL 230 and CHEM 340.

Integrative mechanisms and control systems in cardiovascular and respiratory physiology. Circulation and the distribution and regulation of body fluids. Digestive systems and metabolism.

**BIOL 613GW Human Physiology Laboratory - GVAR (Units: 3)**

Prerequisites: GE Area A2; BIOL 612 or BIOL 630 (may be taken concurrently). Intended for Biology majors.

Experiments in preparation, recording, and analysis of the functioning of human and other vertebrate organ systems and tissues. Lecture, 1 unit; laboratory, 2 units. Extra fee required. (Plus-minus ABC/NC)

**Course Attributes:**

- Graduation Writing Assessment

**BIOL 614 Vertebrate Histology (Units: 4)**

Prerequisites: BIOL 230 and BIOL 240. Intended for Biology majors.

Microscopic anatomy of tissues and organ systems of vertebrates. Lecture, 2 units; laboratory, 2 units. Extra fee required.

**BIOL 615 Molecular Pathophysiology (Units: 3)**

Prerequisites: BIOL 350, BIOL 355, and BIOL 612. Intended for Biology majors.

Globally important diseases caused by genetic errors, environmental factors, or parasites. Each disease is studied at the molecular, cellular, and physiological levels.

**BIOL 616 Cardiorespiratory Physiology (Units: 3)**

Prerequisites: BIOL 230, BIOL 240, BIOL 612 or BIOL 630, and PHYS 121; or permission of the instructor. Intended for Biology majors.

The physiology of the cardiovascular and respiratory systems, and their interrelationship. Organ function in health and disease. (Plus-minus letter grade only)

**BIOL 617 Environmental Physiology (Units: 3)**

Prerequisite: BIOL 612 or BIOL 630. Intended for Biology majors.

The physiological and biochemical mechanisms underlying adaptation of animals to diverse environments. (Plus-minus letter grade only)

**BIOL 618 Biology of Aging (Units: 3)**

Prerequisites: Biology majors and minors; BIOL 212 or BIOL 612, BIOL 350, and BIOL 355.

Biological processes underlying aging. Focus on the molecular mechanisms of aging including specific animal models of aging and age-related changes in the major physiological systems in humans. (Plus-minus letter grade only)

**BIOL 619 Pathophysiology (Units: 3)**

Prerequisites: Biology majors and minors; BIOL 212 or BIOL 612.

The processes underlying disease in the major physiological systems. Focus on understanding the relationship between changes at the molecular, cellular, and tissue levels and their physiological manifestations at the organ and system levels. (Plus-minus letter grade only)

**BIOL 620 Endocrinology (Units: 3)**

Prerequisites: BIOL 230 and BIOL 240.

Introduction to the classes of hormones, sources and synthesis of hormones, endocrine target tissues, signaling pathways, and hormonal regulation within the vertebrate endocrine system. Application to clinical real-world endocrine case studies.

**BIOL 621 Reproductive Physiology (Units: 3)**

Prerequisites: BIOL 230, BIOL 240, BIOL 330, and CHEM 130; BIOL 492 or another course in vertebrate anatomy is recommended. Intended for Biology majors.

Reproductive morphology and physiology of vertebrates.

**BIOL 622 Hormones and Behavior (Units: 3)**

Prerequisites: BIOL 230 and BIOL 240; a course in physiology or endocrinology strongly recommended; or permission of the instructor. Intended for Biology majors.

Effects that hormones exert on behavior. Hormonal activation and organization of behavior and the nervous system. Actions of hormones compared in humans and non-human species.

**BIOL 623 Pharmacology (Units: 3)**

Prerequisite for BIOL 723: Graduate standing.

Prerequisites for BIOL 623: Upper-division standing; BIOL 230 and BIOL 240 with grades of C- or better, BIOL 612, and CHEM 130; GPA of 3.0 or higher; or permission of the instructor.

Pharmacology principles including pharmacokinetics of drug absorption and elimination. Mechanisms of drug action on the body. Commonly used pharmaceutical drugs.

(BIOL 723/BIOL 623 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 625 Hematology (Units: 3)**

Prerequisite: A college-level physiology course. Intended for Biology majors.

Origin and function of mammalian blood cells and plasma. Cell variations in health and disease. Lecture, 2 units; laboratory, 1 unit. Extra fee required.

**BIOL 627 Biophysics (Units: 3)**

Prerequisites: BIOL 230, CHEM 115, and PHYS 121 or equivalents; or permission of the instructor.

Physical description of free energies and driving forces, energetic and timescales of biological processes, interactions of biomolecules, diffusion transport and signaling, protein DNA and membrane structure, molecular motors, cooperative binding, membrane potentials and excitability, and regulation of gene expression.

**BIOL 630 Animal Physiology (Units: 3)**

Prerequisites: BIOL 230\* and BIOL 240\*; CHEM 130\* or CHEM 233\*.

Exploration of the biodiversity of animals living across Earth's habitats with varying ecologies and life-histories. Focus on the basic functional systems of animals, including metabolism, digestion, energetics, thermal physiology, neuronal and sensory systems, endocrine systems, muscle systems, respiratory systems, circulatory systems, and osmotic and ionic processes. Intended for Biology majors.

**BIOL 631 GW Animal Physiology Laboratory - GVAR (Units: 4)**

Prerequisites: GE Area A2; BIOL 612\* or BIOL 630\* (may be taken concurrently).

Approaches to scientific research on the environmental physiology of marine and estuarine organisms with a focus on metabolic processes. Emphasis on scientific writing and communication. Intended for Biology majors. Lecture, 2 units; laboratory 2 units. Extra fee required. (Plus-minus ABC/NC)

**Course Attributes:**

- Graduation Writing Assessment

**BIOL 638 Bioinformatics and Sequence Analysis (Units: 4)**

Prerequisites for BIOL 738: Graduate standing; or permission of the instructor.

Prerequisites for BIOL 638: Upper-division standing; BIOL 230 and BIOL 355\*; concurrent enrollment in BIOL 337\*; GPA of 3.0 or higher; or permission of the instructor.

Principles and methods of biological analysis using computing, including next-gen sequencing, phylogenetics, sequence variation, and gene expression analysis. Includes a series of hands-on bioinformatics projects using real biological data. (Plus-minus letter grade only) (BIOL 738/BIOL 638 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 640 Cellular Neurosciences (Units: 3)**

Prerequisites: BIOL 230, BIOL 240, CHEM 130, and PHYS 121; BIOL 350 and BIOL 612 are recommended. Intended for Biology majors.

Cellular and molecular analysis of neurons. Cellular, synaptic, and retinal neurophysiology. Electrical and chemical mechanisms underlying intraneuronal and inter-neuronal signaling.

**BIOL 642 Neural Systems Physiology (Units: 3)**

Prerequisite: BIOL 328 or BIOL 612.

Communication between neural centers controlling sensory and motor systems, homeostasis, learning, thought, and affect. Connectivity, neurophysiological regulation, and neuropathology. (Plus-minus letter grade only)

**BIOL 644 LEADerS Service Learning Course: Learners Engaged in Advocating for Diversity in Science (Units: 4)**

Prerequisites: Restricted to upper-division standing; BIOL 230 and BIOL 240; BIOL 350 or BIOL 355 or BIOL 357.

Examination of issues involving equity and diversity of scientific teaching with a specific focus on the development of inclusive practices within the upper-division courses in Biology. Students will be involved in developing assessments in their partnerships and either implementing (PALS) or developing (LEADS) active learning exercises. Seminar, 2 units; activity, 2 units. [CSL may be available]

**BIOL 654 Peer Assistants for Learning Science (PALS) (Units: 4)**

Prerequisites: BIOL 230\*.

Intended for Biology majors interested in revisiting and applying their science knowledge, understanding importance of diversity, equity, and inclusion in their discipline, gaining insights into teaching science in the university setting, exploring the field of science teaching as a potential career, and learning science through teaching science. Work with faculty and lecturers who have been trained in scientific teaching and are interested in expanding their capacity for active learning and inclusive teaching practices in their course. Lecture, 2 units; Activity, 2 units. [CSL may be available]

**BIOL 667 Optical Engineering for the Biological Sciences (Units: 3)**

Prerequisites: MATH 226; BIOL 230 or CHEM 215 with a grade of C or better; or permission of the instructor.

A hands-on introduction to applying advances in low-cost computers and digital cameras to microscope design. Emphasis on learning the fundamentals of optical engineering and image processing used in digital microscopy, as well as essential skills in optical design, instrumentation, machining, and fabrication. Includes building a lensless microscope capable of capturing and processing images of plankton. Lecture, 1 unit; laboratory, 2 units. (Plus-minus letter grade; RP grading only) (This course is offered as BIOL 667 and CHEM 667. Students may not repeat the course under an alternate prefix.)

**BIOL 670GW Ecology and Evolution of Marine Systems I - GEAR (Units: 6)**

Prerequisites: GE Area A2; BIOL 240, BIOL 458 or equivalents with grades of C or better; concurrent enrollment in BIOL 671 and BIOL 699 or BIOL 897.

Introduces highly motivated students to ecological and evolutionary processes that structure subtidal marine environments from the top down (emphasizing effects of predation). Students conduct independent field research and develop scientific writing skills. Lecture, 4 units; laboratory, 2 units. Extra fee required. (Plus-minus letter grade only)

**Course Attributes:**

- Graduation Writing Assessment

**BIOL 671 Ecology and Evolution of Marine Systems II (Units: 6)**

Prerequisites: BIOL 240 and BIOL 458 with grades of C or better; concurrent enrollment in BIOL 670GW and BIOL 699 or BIOL 897.

Introduction to ecological and evolutionary processes that structure subtidal marine environments from the bottom up (emphasizing foundational habitats). Lecture, 4 units; laboratory, 2 units. Extra fee required. (Plus-minus letter grade only)

**Course Attributes:**

- Environmental Sustainability

**BIOL 681 Climate Action: Applied Learning for Real World Change (Unit: 1)**

Prerequisites: Two courses in the Climate Change Causes, Impacts, and Solutions Certificate.

Apply an evolving understanding of climate change causes, impacts, and solutions towards real-world action. Integrate a climate change component into existing major requirements, internships, service learning, employment, fellowships, and/or faculty-student research collaborations. Share the outcomes with peers and reflect on experiences together, as well as participate in peer-led and instructor-led learning exchanges on Climate Change themes. [CSL may be available]

**BIOL 694 Cooperative Internship in Biology (Units: 2-4)**

Prerequisites: Restricted to sophomore standing and above; Biology majors; permission of Biology faculty adviser.

Written and oral report of work performed with an outside agency and a requested written report from the agency supervisor. Evaluation of work by a Biology adviser and/or faculty committee. May be repeated for a total of 16 units.

**BIOL 698 Strategies for Successful Graduate Applications in STEM (Units: 2)**

Prerequisite: Senior standing and permission of the instructor.

Introduction to graduate research skills, including written and oral communication, equity in science, reading and analyzing research, responsible conduct in research, and rigor and responsibility in STEM. May be repeated for a total of 4 units.

(This course is offered as BIOL 698 and SCI 698. Students may not repeat the course under an alternate prefix.)

**Topics:**

- a. Developing a Scientific Identity
- b. Skills to Succeed as a Scientist
- c. Developing a Strong Doctoral Application Package
- d. Careers with a Doctoral Degree

**BIOL 699 Independent Study in Biology (Units: 1-3)**

Prerequisites: Restricted to senior Biology majors; permission of the department and instructor.

Special study in the laboratory, field, or library under the direction of a member of the department. The student must present a written detailed report of the work accomplished to the staff of the department. May be repeated for credit.

**BIOL 700 Introduction to Research Skills (Units: 3)**

Prerequisite: Restricted to graduate standing or permission of the instructor.

Introduction to the theory and practice of skills used by research scientists that include research literature searches, basic concepts in visualizing and interpreting data, analyzing conclusions of research articles, ethics, and safety. Assignments support completion of the degree requirements, including forming a thesis committee and defining a research objective. (Plus-minus letter grade only)

**Topics:**

- a. Research Skills in Genetics and Epigenetics
- b. Research Skills in Ecology and Evolution
- c. Research Skills in Endocrinology
- d. Research Skills in Developmental Biology
- e. Research Skills to Study Hormones and Behavior
- f. Research Skills in Neuroscience
- g. Research Skills in Community Ecology
- h. Research Skills in Conservation Biology
- i. Research Skills in Cell Biology

**BIOL 701 Strategies for Successful PhD Applications in STEM (Units: 2)**

Prerequisite: Graduate standing and permission of the instructor.

Introduction to graduate research skills, including written and oral communication, equity in science, reading and analyzing research, responsible conduct in research, and rigor and responsibility in STEM. May be repeated for a total of 8 units.

(This course is offered as BIOL 701 and SCI 701. Students may not repeat the course under an alternate prefix.)

**Topics:**

- a. Introduction to Graduate Skills
- b. Developing Skills Towards the MS Degree
- c. Preparation for PhD Applications
- d. Careers After a Doctoral Degree

**BIOL 702 Biology of the Algae (Units: 3)**

Prerequisite for BIOL 702: Graduate standing or permission of the instructor.

Prerequisites for BIOL 502: Upper-division standing; BIOL 230 and BIOL 240; GPA of 3.0 or higher; or permission of the instructor. Intended for Biology majors.

Collection, preservation, identification, and culturing of marine and freshwater algae. Comparative studies of morphology, life history, and ecology. Field trips. Seminar, 2 units; laboratory, 1 unit. Extra fee required. (BIOL 702/BIOL 502 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 708 Scientific Methods for Professional Aquatic Scientists (Units: 3)**

Prerequisite: Graduate standing or permission of the instructor.

Introduction to research tools and approaches used by scientists including software for data analysis and presentation, using scientific literature, experimental design, writing scientific papers and proposals, professional communication (oral, poster, and letter), and time and stress management. (Plus-minus letter grade only)

**BIOL 710 Advanced Biometry (Units: 3)**

Prerequisite: BIOL 458.

Use of computers for critical data evaluation and decision-making. Accessing and using available statistical packages, database management, construction of phylogenetic tree models, and advanced statistical analyses. No prior computer experience required. Seminar, 2 units; laboratory, 1 unit. Extra fee required.

**BIOL 715 Field Methods in Ecology and Evolution (Unit: 1)**

Prerequisite for BIOL 715: Graduate standing or permission of the instructor.

Prerequisites for BIOL 315: Restricted to upper-division standing; BIOL 240\* and BIOL 458\* with grades of C or better; GPA of 3.0 or better; or permission of the instructor.

An introduction to sampling and experimental design for environmental biologists. An overview of methods for sampling a variety of organisms in specific habitats. Principles of design, execution, and interpretation of data derived from field experiments will be explored. Data analysis and visualization will be emphasized.

(BIOL 315/BIOL 715 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 716 Skills for Scientific Proposal Writing (Units: 3)**

Prerequisites: Graduate standing and permission of the instructor.

Development of technical writing skills through the process of writing and editing research proposals based on the students' own research projects.

**BIOL 719 Exploring and Practicing Science Communication (Units: 2)**

Prerequisite: Graduate standing or permission of the instructor.

Communicating about science is a natural part of any scientist's life. Delve into what others have learned about science communication, experiment with tools that communicate work and goals, and develop skills to engage a broad range of people in how science is relevant and important.

(This course is offered as BIOL 719 and SCI 719. Students may not repeat the course under an alternate prefix.)

**BIOL 723 Pharmacology (Units: 3)**

Prerequisite for BIOL 723: Graduate standing.

Prerequisites for BIOL 623: Upper-division standing; BIOL 230 and BIOL 240 with grades of C- or better, BIOL 612, and CHEM 130; GPA of 3.0 or higher; or permission of the instructor.

Pharmacology principles including pharmacokinetics of drug absorption and elimination. Mechanisms of drug action on the body. Commonly used pharmaceutical drugs.

(BIOL 723/BIOL 623 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 738 Bioinformatics and Sequence Analysis (Units: 4)**

Prerequisites for BIOL 738: Graduate standing; or permission of the instructor.

Prerequisites for BIOL 638: Upper-division standing; BIOL 230 and BIOL 355\*; concurrent enrollment in BIOL 337\*; GPA of 3.0 or higher; or permission of the instructor.

Principles and methods of biological analysis using computing, including next-gen sequencing, phylogenetics, sequence variation, and gene expression analysis. Includes a series of hands-on bioinformatics projects using real biological data. (Plus-minus letter grade only)

(BIOL 738/BIOL 638 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 741 Electron Microscopy (Units: 4)**

Prerequisites: Graduate or senior standing and permission of the instructor.

Introduction to electron microscopy with a focus on instrumentation, image formation and interpretation, x-ray microanalysis, sample preparation, artifacts, and related techniques. Laboratory work includes operation of the electron microscope, x-ray microanalysis, and the preparation of biological and inorganic specimens for scanning and transmission electron microscopy. Seminar, 2 units; laboratory, 2 units. Extra fee required. (Plus-minus letter grade only)

(This course is offered as BIOL 741, CHEM 741, and EARTH 741. Students may not repeat the course under an alternate prefix.)

**BIOL 743 Cell and Molecular Techniques (Units: 3)**

Prerequisites: Graduate standing; BIOL 357 (may be taken concurrently), CHEM 340, and CHEM 341.

Lecture and discussion of modern techniques and design of strategies used in cell and molecular biology research. Includes discussion of societal issues.

**BIOL 750 Science Teaching for Scientists I (Units: 2)**

Prerequisite: Graduate standing or permission of the instructor.

Introduction to practical teaching strategies, science education theory and research, and scientific teaching to SF State graduate students who are teaching science in a variety of contexts. May be repeated for a total of 4 units. (Plus-minus letter grade only)

(This course is offered as SCI 750 and BIOL 750. Students may not repeat the course under an alternate prefix.)

**BIOL 760 Cancer Biology (Units: 3)**

Prerequisites for BIOL 760: Graduate standing; coursework in cell or molecular biology; or permission of the instructor.

Prerequisites for BIOL 360: Upper-division standing; BIOL 350\* and BIOL 355\*; GPA of 3.0 or better, or permission of the instructor.

The molecular and cellular basis of cancer. Emphasis on potential therapeutic targets, including cell cycle regulators, signal transduction mechanisms, cellular differentiation factors, oncogenes, and tumor suppressors. (Plus-minus letter grade only)

(BIOL 760/BIOL 360 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 763 Molecular Biology of Cancer (Units: 2)**

Prerequisites: Graduate standing and a Biochemistry course.

The biology, diagnosis, and treatment of cancer focuses on how recent advances have been achieved by the application of molecular biology principles and techniques. Topics include metastasis, angiogenesis, carcinogenesis, genetics, therapeutics, and potential future advances. (Plus-minus letter grade only)

**BIOL 781 Biomedical Virology Foundations (Units: 3)**

Prerequisite: Graduate standing or permission of the instructor.

Topic to be specified in Class Schedule. Core lectures with emphasis on virology. May be repeated when topics vary.

**Topics:**

- a. Human Retroviruses

**BIOL 782 Developmental Biology (Units: 3)**

Prerequisites for BIOL 782: Graduate standing; BIOL 350 and BIOL 355 or equivalents with grades of C- or better; or permission of the instructor.

Prerequisites for BIOL 382: Upper-division standing; BIOL 350 and BIOL 355 with grades of C- or better; GPA of 3.0 or higher; or permission of the instructor. Intended for Biology and Biochemistry majors.

Early embryonic development including the exploration of the molecular genetic basis for tissue differentiation. Gene regulation, chromatin, sex determination, oncogenesis, aging, and pattern formation.

(BIOL 782/BIOL 382 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 784 Biomedical Virology Applications (Units: 3)**

Prerequisite: Graduate standing or permission of the instructor.

Topics to be specified in the Class Schedule. Seminar, 1 unit; laboratory, 2 units. May be repeated when topics vary.

**Topics:**

- a. Cell Culture and Stem Cell Techniques

**BIOL 793 Advances in Biomedical Hematology (Units: 2)**

Prerequisite: Graduate standing or permission of the instructor.

Topics to be specified in Class Schedule. May be repeated when topics vary.

**Topics:**

- a. Reproductive Technologies

**BIOL 800 Mushroom Taxonomy (Units: 3)**

Prerequisites: Graduate or senior standing; BIOL 504 or equivalent; or permission of the instructor.

Mushroom morphology, microscopic anatomy, and taxonomy including biochemical and cytological aspects and ecology and artificial cultivation of the macroscopic fungi. Seminar, 2 units; laboratory, 1 unit. Extra fee required.

**BIOL 801 Population Genetics (Units: 3)**

Prerequisite: Restricted to graduate Biology students or permission of the instructor.

The genetic basis of evolution. Effects of mating system, drift, migration, and selection on genetic variation. Quantitative genetics and applications of molecular techniques in evolutionary biology. Seminar, 2 units; laboratory, 1 unit. Extra fee required. (Plus-minus letter grade only)

**BIOL 803 Core Concepts of Biotechnology (Units: 3)**

Prerequisites: BIOL 355 or BIOL 357 or CHEM 340 or permission of the instructor.

Introductory course for students interested in careers in biotechnology. Core concepts of biotechnology to keep abreast of current trends, biomedical applications, and historical foundations. (Plus-minus letter grade only)

**BIOL 804 Life Science Careers (Units: 2)**

Prerequisites: Restricted to graduate Biology students; permission of the instructor.

Introduction to career opportunities for biology life science students after graduation, choosing a career, and the necessary tools to pursue a chosen field.

**BIOL 806 Exploratory Data Science for Scientists (Units: 4)**

Prerequisite: Graduate standing; or upper-division standing with permission of the instructor; a college-level computer science course.

Introduction to the fundamentals of data science through its applications in biology and chemistry research. Exploration of data preparation, analysis, and reporting using real-world scientific datasets. Lecture, 3 units; activity, 1 unit.

(This course is offered as BIOL 806 and CHEM 806. Students may not repeat the course under an alternate prefix.)

**BIOL 807 Coding Community for Data Science Components of Independent Research Projects (Unit: 1)**

Prerequisites: Graduate standing; BIOL 806/CHEM 806 or equivalent (concurrent enrollment recommended); or permission of the instructor.

Applications of data science principles to independent research for a master's thesis. May be repeated for a total of 3 units.

(This course is offered as CHEM 807 and BIOL 807. Students may not repeat the course under an alternate prefix.)

**BIOL 808 Professional Prospects for Quantitative Biologists, Data Scientists, and Bioinformaticians (Unit: 1)**

Prerequisite: BIOL 806\*/CHEM 806\*.

Connect with data scientists from Bay Area industries, universities, and government agencies. Data scientists will be invited to campus to discuss current trends in the industry, specific positions and roles achievable for students post-graduation, CV composition, job interview skills, and professional experiences in a broad set of workplaces. Practice professional communication skills and experience post-graduate workplace culture. (CR/NC grading only)  
(This course is offered as BIOL 808 and CHEM 808. Students may not repeat the course under an alternate prefix.)

**BIOL 814 Plant Biodiversity and California Field Botany (Units: 5)**

Prerequisite for BIOL 814: Graduate standing or permission of the instructor.

Prerequisites for BIOL 514: Upper-division standing; BIOL 230 and BIOL 240\*; GPA of 3.0 or higher; or permission of the instructor.

Examine plant biodiversity through principles of classification, phylogenetic relationships, and global biogeography. Hands-on experience gained through numerous field trips and laboratory exercises with live plant material offers practice in the identification of any plant species, collection of herbarium specimens, and other field botany techniques. Expertise gained of all major native Californian plant lineages and ecosystems, including those used by indigenous peoples. Intended for Biology majors. Lecture, 2 units; laboratory, 3 units. (Plus-minus letter grade only.)

(BIOL 814/BIOL 514 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 815 Advanced Phylogenetic Analysis (Units: 4)**

Prerequisite: Graduate standing or permission of the instructor.

Methods and techniques of phylogenetic inference. Parsimony, maximum likelihood, quantitative phylogenetic analysis, and comparative methods. Molecular data in evolution. Lecture, 3 units; laboratory, 1 unit. Extra fee required. (Plus-minus letter grade only)

**BIOL 830 Advanced Conservation Biology (Units: 3)**

Prerequisites: Graduate standing; BIOL 530; or permission of the instructor.

Theory and practice of nature conservation, traditional resource management, and the new theory of the conservation of small populations. Seminar, 2 units; laboratory, 1 unit. Extra fee required. (Plus-minus letter grade only)

**BIOL 832 Health Disparities in Cancer (Units: 3)**

Prerequisite for BIOL 832: Graduate standing or permission of the instructor.

Prerequisites for BIOL 332: Restricted to upper-division standing; BIOL 230, BIOL 240, and BIOL 355; GPA of 3.0 or higher; or permission of the instructor.

Major determinants of health disparities in cancer including ethnic differences in biology and prevention and treatment of cancer. Strategies to overcome these disparities through research, health education, outreach, advocacy, and policy changes.

(BIOL 832/BIOL 332 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**Course Attributes:**

- Am. Ethnic & Racial Minorities
- Global Perspectives
- Social Justice

**BIOL 840 Community Ecology (Units: 3)**

Prerequisites: Graduate or senior Biology students; an ecology course.

Modern concepts and approaches to natural community structure, organization, and dynamics. Historical and current theoretical models, forces structuring communities, interactions among communities, and the role of exotic species. (Plus-minus letter grade only)

**BIOL 848 Behavioral Ecology (Units: 3)**

Prerequisite: Graduate standing or permission of the instructor.

Evolution of behavior including optimal foraging, predation, sexual selection, social organization, habitat selection, and communication. (Plus-minus letter grade only)

**BIOL 860 Advances in Biology Education Research (Units: 2)**

Prerequisite: Graduate standing or permission of the instructor.

Students read and present primary research articles, facilitate discussions, write article analyses, and develop a mini-grant proposal on a biology education research question. May be repeated for a total of 4 units.

**BIOL 861 Advances in Cell and Molecular Biology (Units: 2)**

Prerequisite: Graduate standing or permission of the instructor.

Examine current topics and advances in cell, molecular, and developmental biology. Topics to be specified in the Class Schedule. May be repeated when topics vary.

**Topics:**

- a. Gene Expression
- b. Biology of the Cell Cycle
- c. Topics in Development
- d. Chromatin Structure and Function
- e. Stem Cell Biology
- f. Pharmacogenomics
- g. Genome Evolution
- h. Genetic Systems: Forms and Consequences
- i. Topics in Epigenetics
- j. Topics in Fluorescence Microscopy
- k. Nextgen Sequencing Approaches in Biology
- l. Psychedelic Neuroscience

**BIOL 862 Advances in Ecology and Systematic Biology (Units: 2)**

Prerequisite: Graduate standing or permission of the instructor.

Topics to be specified in the Class Schedule. May be repeated when topics vary.

**Topics:**

- a. Contemporary Methods in Systematics
- b. Evolution/Phylogeny of Angiosperms
- c. Fungal Symbioses
- d. Recent Advances in Fungal Systematics
- e. Current Topics in Ecology
- f. Current Topics in Evolution
- g. Current Topics in Behavioral Biology
- h. Tropical Ecology
- i. Amphibian Conservation
- j. Advances in Botany
- k. Ecological Theory and Philosophy
- l. Nextgen Sequencing Approaches in Ecology, Systemat

**BIOL 863 Advances in Marine Biology (Units: 2)**

Prerequisite: Graduate standing or permission of the instructor.

Current topics of research in aquatic biology and ecology. Topics to be specified in the Class Schedule. May be repeated when topics vary.

**Topics:**

- a. Plankton Ecology
- b. Physiological and Biochemical Adaptations
- c. Ecosystems Ecology
- d. Marine Symbioses
- e. Ecophysiology of Harmful Algal Blooms
- f. Aquatic Communities Seminar
- g. Molecular Ecology, Molecular Evolution and Evoluti
- h. Global Climate Warming
- i. Advanced Ichthyology
- j. Disease Dynamics
- k. Global Plastic Pollution: Problems and Solutions

**BIOL 865 Advances in Physiology and Behavioral Biology (Units: 2)**

Prerequisite: Restricted to graduate Biology students or permission of the instructor.

Topics to be specified in the Class Schedule. May be repeated when topics vary.

**Topics:**

- a. Environmental Physiology
- b. Physiological Integrations
- c. Current SFSU Physiology Research
- d. Extreme Biology: Physiological Adaptations to Life
- e. Arthropod Physiology
- f. Biologic Basis of Neurologic Disease



**BIOL 870 Biology Colloquium (Units: 2)**

Prerequisite: Graduate standing or permission of the instructor.

Presentation of student and faculty research, recent journal articles, and presentations by outside speakers. May be repeated for a total of 4 units. (Plus-minus letter grade only)

**BIOL 871 Colloquium in Microbiology, Cell and Molecular Biology (Units: 2)**

Prerequisite: Graduate standing or permission of the instructor.

Presentation of student and faculty research, recent journal articles, and presentations by outside speakers. Does not fulfill the graduate seminar requirement. May be repeated for a total of 4 units. (Plus-minus letter grade only)

**BIOL 872 Colloquium in Ecology, Evolution, and Conservation (Units: 2)**

Prerequisite for BIOL 872: Graduate standing.

Prerequisites for BIOL 572: Upper-division standing; GPA of 3.0 or higher; or permission of the instructor.

Presentations of student and faculty research, recent journal articles, and by outside speakers. Student speakers receive graduate seminar credit. May be repeated for a total of 8 units. (BIOL 872/BIOL 572 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**BIOL 877A Exploratory Data Analysis for Scientists (Units: 3)**

Prerequisite: Restricted to graduate standing.

Work in teams to learn programming and statistics applied to original research projects.

**BIOL 881 Seminar: Cell and Molecular Biology (Unit: 1)**

Prerequisite: Graduate standing or permission of the instructor.

Topics to be specified in the Class Schedule. May be repeated for a total of 4 units when topics vary.

**Topics:**

- a. Current Research Topics in Biology

**BIOL 883 Seminar: Marine Biology (Units: 2)**

Prerequisite: Graduate standing or permission of the instructor.

Seminar on topics in marine biology. Topics to be specified in the Class Schedule.

**Topics:**

- a. Current EOS Research

**BIOL 890 Cooperative Internship (Units: 2-3)**

Prerequisite: Graduate standing.

For students who are conducting a cooperative internship and work-related research experience. May be repeated for a total of 6 units.

**BIOL 891 Biomedical Research Design (Units: 2)**

Prerequisites: GET requirement and a specific research topic approved by a mentor.

Exercises encompass the elements of biomedical laboratory science research proposals including needs assessment, literature review, clinical significance, feasibility, controls, materials and methods, budget, data presentation, human/animal aspects, record keeping, reference notation, and statistical significance. (Plus-minus letter grade only)

**BIOL 895 Research Project (Units: 4)**

Prerequisites: Permission of the instructor; approval of Advancement to Candidacy (ATC) and Culminating Experience (CE) forms by Graduate Studies before registration.

Supervised independent and original laboratory or field investigation. Guidelines are available at the Biology department office. (CR/NC grading only)

**BIOL 896 Directed Reading (Unit: 1)**

Prerequisites: Approval of the department; permission is required for concurrent enrollment in BIOL 897 or BIOL 895.

Supervised preparation of the research proposal for a research project or thesis research and completion of the preliminary oral examination. May not be repeated. (Plus-minus letter, RP)

**BIOL 897 Research (Units: 1-6)**

Prerequisites: Undergraduate degree in Biology and graduate standing.

Independent and original laboratory or field investigation under the supervision of a faculty member. May be repeated. (Plus-minus letter grade, CR/NC, RP)

**BIOL 898 Master's Thesis (Units: 4)**

Prerequisites: Permission of the instructor; approval of Advancement to Candidacy (ATC) and Culminating Experience (CE) forms by Graduate Studies before registration.

(CR/NC, RP)

**BIOL 899 Independent Study (Unit: 1)**

Prerequisite: Restricted to graduate Biology students.

Study in the laboratory or library under the direction of a member of the department. May be repeated for a total of 4 units.