**Biology**

**College of Science and Engineering**
Interim Dean: Carmen Domingo

**Department of Biology**
Hensill Hall 538
Phone: (415) 338–1548
Website: biology.sfsu.edu (http://biology.sfsu.edu)

Chair: Laura Burrus
Graduate Coordinator: Diana Chu
Graduate advisors:
- Cell and Molecular Biology/ Microbiology: D. Chu
- Ecology, Evolution, and Conservation Biology: A. Zink
- Marine Biology: Jonathon Stillman
- 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).

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

Graduate degree programs provide advanced course work, 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)
- Romberg Tiburon Center for Environmental Studies
- Sierra Nevada Field Campus
- Moss Landing Marine Laboratories

**Collaborative Programs:**
Romberg Tiburon Center for Environmental Studies
Opportunities for graduate and undergraduate study in marine biology are enhanced by the Romberg Tiburon Center for Environmental Studies (RTC), SF State’s marine and estuarine research and teaching laboratory situated on San Francisco Bay in Marin County. RTC faculty and research scientists offer courses in marine and estuarine sciences, a Masters of Science in Marine Science, and supervise graduate student research and undergraduate independent study projects.

**California Academy of Sciences**
The Department of Biology and the California Academy of Sciences (CAS) 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 CAS who have joined the department as research professors contribute to the teaching program, offer seminars and other courses at CAS 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. New 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, in 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 nonprofit organizations or continue to other advanced degrees. The long term career outlook for professional science master's graduates is excellent.

**Professors**
Bayliss, Boyer, Breckler, Burrus, Carpenter, L. Chen, Chu, Cohen, Connor, Desjardin, Domingo, Goldman, Hafernik, He, LeBuhn, Márquez-Magaña, Parker, Patterson, Ramirez, Romeo, Rothman, Routman, Spicer, Stillman, Tanner

**Associate Professors**
J. Chen, Crow-Sanchez, de la Torre, Denetclaw, Fuse, Moffatt, Pasion, Sehgal, Vredenburg, Weinstein

**Assistant Professors**
Chan, Pennings, Riggs, Roy, Swei, Zink, Simonin
San Francisco State University Bulletin 2017-2018

Research Associate Professor
Cipriano

California Academy of Sciences Research Professors
Alemseged, Almeda, Bennett, Blackburn, Burke, Daniel, Drewes, Dumbacher, Fisher, Fritsch, Gosliner, Griswold, Kavanaugh, McCosker, Mooi, Rocha, Roopnarine, Simison, Steiner, Van Syoc, G. Williams

Romberg Tiburon Center Research Professors
Cochlan, Dugdale, Kimmerer, Wilkerson

Majors

- Bachelor of Arts in Biology, General (bulletin.sfsu.edu/colleges/science-engineering/biology/ba-general-biology)
- Bachelor of Science in Biology: Concentration in Botany (bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-botany)
- Bachelor of Science in Biology: Concentration in Cell and Molecular Biology (bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-cell-molecular-biology)
- Bachelor of Science in Biology: Concentration in Ecology (bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-ecology)
- Bachelor of Science in Biology: Concentration in Marine Biology and Limnology (bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-marine-biology-limnology)
- Bachelor of Science in Biology: Concentration in Microbiology (bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-microbiology)
- Bachelor of Science in Biology: Concentration in Physiology (bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-physiology)
- Bachelor of Science in Biology: Concentration in Zoology (bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-zoology)

Minor

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

Certificate

- Certificate in Biotechnology (bulletin.sfsu.edu/colleges/science-engineering/biology/certificate-biotechnology)

Masters

- Master of Science in Biology: Concentration in Cell and Molecular Biology (bulletin.sfsu.edu/colleges/science-engineering/biology/ms-biology-concentration-cell-molecular-biology)
- Master of Science in Biology: Concentration in Ecology, Evolution, and Conservation Biology (bulletin.sfsu.edu/colleges/science-engineering/biology/ms-biology-concentration-eecb)
- Master of Science in Biology: Concentration in Marine Biology (bulletin.sfsu.edu/colleges/science-engineering/biology/ms-biology-concentration-marine-biology)
- Master of Science in Biology: Concentration in Microbiology (bulletin.sfsu.edu/colleges/science-engineering/biology/ms-biology-concentration-microbiology)
- Master of Science in Biology: Concentration in Physiology and Behavioral Biology (bulletin.sfsu.edu/colleges/science-engineering/biology/ms-biology-concentration-physiology-behavioral-biology)

Certificate

- Certificate in Genetic Engineering (bulletin.sfsu.edu/colleges/science-engineering/biology/certificate-genetic-engineering)

BIOL 100 Human Biology (Units: 3)
Course Attributes:
- E1: Lifelong Learning Develop
- B2: Life Science
- Social Justice

BIOL 101 Human Biology Laboratory (Unit: 1)
Prerequisite: BIOL 100.
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)
Intended for non-biology majors. World of plants, their place in nature, and the relation to humans. Growing plants, field observations, and studies of the economic uses of plants. Classwork, 2 units; laboratory and fieldwork, 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 near shore communities of plants, animals, and microbes. Emphasis is on marine biological and chemical processes and environmental issues both locally and globally.
Course Attributes:
- B2: Life Science
- Environmental Sustainability
BIOL 170 Animal Diversity (Units: 3)
Intended for non-biology majors.
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.
Course Attributes:
• B2: Life Science
• Environmental Sustainability

BIOL 171 Animal Diversity Laboratory (Unit: 1)
Prerequisite: BIOL 170 (may be taken concurrently).
Examination of photographic specimens of animal species, their habitats, and their anatomy. Computer exercises to illustrate evolutionary, ecological, and physiological principles. Extra fee required.

BIOL 176 Science and Politics of Stem Cell Biology (Units: 3)
Not open to biology majors.
Foundation for understanding concepts in stem cell biology, social, and political issues in stem cell research and regenerative medicine.
Course Attributes:
• B2: Life Science
• Am. Ethnic & Racial Minorities
• Social Justice

BIOL 210 General Microbiology and Public Health (Units: 3)
Intended for non-biology majors.
Basic concepts of microbiology; practical applications to medicine, public health, and the environment.

BIOL 211 General Microbiology and Public Health Laboratory (Unit: 1)
Prerequisite: BIOL 210 (may be taken concurrently). Intended for non-biology majors.
Laboratory techniques in isolation, enumeration, and identification of microorganisms. Extra fee required.

BIOL 212 Principles of Human Physiology (Units: 3)
Prerequisites: CHEM 101 or CHEM 115, BIOL 100 and BIOL 101 or BIOL 210, with grades of C or better. Intended for non-majors.
Physiology of human organ systems and principles of homeostasis. [Formerly BIOL 610]

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. [Formerly BIOL 611]

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; 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 majors and minors in biology and biochemistry, majors in kinesiology, and majors in environmental studies under the natural resources management and conservation concentration B.S. program.
Fundamentals of biology: chemical basis of life, cell structure, bioenergetics, plant and animal physiology, and genetics. Classwork, 3 units; laboratory, 2 units. Extra fee required.

BIOL 240 Introductory Biology II (Units: 5)
Prerequisite: BIOL 230 with a grade of C- or better.
Fundamentals of biology: gene expression, development, evolution, ecology, and the diversity of microbes, plants, and animals. Classwork, 4 units; laboratory, 1 unit. Extra fee required.

BIOL 300 Nature Study (Units: 3)
Prerequisite: College course in biology. Intended for non-biology majors.
Identification, structure, adaptation, life history, habits, habitat, economic status, conservation of common plants and animals. Two all-day field trips scheduled on two separate weekends. Classwork, 2 units; laboratory and fieldwork, 1 unit. Extra fee required.
Course Attributes:
• UD-B: Physical Life Science
• Environmental Sustainability

BIOL 310 Biology for Today's World (Units: 3)
Prerequisite: College course in biology.
Course Attributes:
• UD-B: Physical Life Science
• Environmental Sustainability

BIOL 317 Ecology of California (Units: 3)
Prerequisite: College course in biology.
Examines ecology, natural history of California, and impact humans have on the environment in a perceptual and scientific content. Focus on principal processes underlying the evolution/diversity of California's terrestrial/aquatic flora/fauna.
BIOL 318 Our Endangered Planet (Units: 3)
Prerequisite: One course in college biology. Intended for non-majors.

The effect of humans on the ecology of our environment. Species extinctions, the role of genetics, nature reserves, biology of small populations, and restoration ecology.

Course Attributes:
- E1: Lifelong Learning Develop
- UD-B: Physical Life Science
- Am. Ethnic & Racial Minorities
- Environmental Sustainability
- Global Perspectives

BIOL 322 Human Sexuality: Integrative Science (Units: 3)
Prerequisite: BIOL 100 or equivalent or consent of instructor.

Presents basic scientific foundations of human sexuality. Explores the symbiotic relationships between biology and society throughout the life cycle. Discusses the challenges associated with human sexuality and the tools for dealing with them.

BIOL 326 Disease! (Units: 3)
Prerequisite: BIOL 100 or equivalent or consent of instructor. Intended for non-majors.

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.

Course Attributes:
- UD-B: Physical Life Science
- Global Perspectives
- Social Justice

BIOL 327 AIDS: Biology of the Modern Epidemic (Units: 3)
Prerequisite: One course in college biology. Intended for biology majors and non-majors.

Modern epidemic of AIDS is viewed from biological and social perspectives: virology, epidemiology, the immune system, disease states, diagnosis, treatment, prevention, public health issues, sexuality, response of the scientific community, comparison with other historical epidemics.

Course Attributes:
- UD-B: Physical Life Science
- Global Perspectives

BIOL 328 Human Anatomy (Units: 4)
Prerequisites: Restricted to sophomore standing or above with a major in biology, biochemistry, chemistry, clinical science, or kinesiology. BIOL 230 with a grade of C- or better, or consent of instructor.

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

BIOL 330 Human Sexuality (Units: 3)
Prerequisite: One course in college biology or consent of instructor. Intended for B.A. in General Biology majors and non-majors.

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.

Course Attributes:
- E1: Lifelong Learning Develop
- UD-B: Physical Life Science

BIOL 332 Health Disparities in Cancer (Units: 3)
Prerequisite for BIOL 832: Graduate standing or consent of instructor.
Prerequisites for BIOL 332: BIOL 230, BIOL 240, BIOL 355.

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, BIOL 355. Intended for biology majors and non-majors.

The principles of evolutionary biology, concentrating on basic population genetic mechanisms and methods of analysis.

BIOL 344GW Research Skills - GWAR (Units: 3)
Prerequisite for BIOL 844: Graduate standing or consent of instructor.
Prerequisites for BIOL 344GW: ENG 214 or equivalent with a grade of credit or C- or better, BIOL 230, BIOL 240, and consent of instructor.

Practical skills for successfully conducting undergraduate research. Focus on experimental design, critical review of literature, effective oral and written scientific presentation, and development of research plan.

(Plus/minus ABC/NC)

(BIOL 844/BIOL 344GW is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

Course Attributes:
- Graduation Writing Assessment
BIOL 349 Bioethics (Units: 3)
Prerequisite for BIOL 849: Graduate standing or consent of instructor. Prerequisite for BIOL 349: Upper division standing.
Biomedical ethics: experiments on humans and laboratory animals, genetic engineering, in vitro fertilization, fetal research, abortion, the health care system, organ transplants, death and dying.
(BIOL 849/BIOL 349 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)
Course Attributes:
- UD-B: Physical Life Science
- Social Justice

BIOL 350 Cell Biology (Units: 3)
Prerequisites: Restricted to upper division standing; biology and biochemistry majors; BIOL 230, BIOL 240, CHEM 130 with a grade 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 - GWAR (Units: 4)
Prerequisites: Upper division standing; restricted to Biology and Biochemistry majors; ENG 214 or equivalent with a grade of CR or C- or better, BIOL 350, BIOL 355.
Experiments introducing laboratory techniques: microscopy, cytochemistry, spectrophotometric quantitation of macro-molecules, organelle isolation, animal cell culture, gene expression, protein analysis, recombinant DNA techniques. Classwork, 2 units; laboratory, 2 units. Extra fee required. (Plus/minus ABC/NC)
Course Attributes:
- Graduation Writing Assessment

BIOL 355 Genetics (Units: 3)
Prerequisites: Restricted to upper division standing; Biology and Biochemistry majors; BIOL 230, BIOL 240, CHEM 130 with a grade 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. Intended for Biology majors.
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.

BIOL 358 Forensic Genetics: Math Matters (Units: 4)
Prerequisites: Restricted to sophomore, junior, or senior students in Biology, Chemistry, Mathematics, and Computer Science programs; BIOL 230 with a grade of C- or better, MATH 199, or consent of instructor.
Statistical forensic genetics with a focus on social impact; statistical exploration and analyses in R programming language; original scientific research project; critical analysis of forensics in the media; forensic genetics policy proposal project. Classwork, 3 units; laboratory, 1 unit. (Plus-minus letter only)

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.
Examines the evolution of animal diversity by evaluating 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, BIOL 355 or equivalents with grades of C- or better; or consent of instructor. Prerequisites for BIOL 382: BIOL 350, BIOL 355 with grades of C- or better. Intended for Biology and Biochemistry majors.
Early embryonic development: exploration of the molecular genetic basis for tissue differentiation. Gene regulation, chromatin, sex determination, oncogenesis, aging, and pattern formation. Extra fee required.
(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 391 Microscopy and Photomicrography (Units: 2)
Prerequisite: One course in college physics or consent of instructor. Intended for upper division Biology majors.
The use of the microscope with brightfield, darkfield, phase contrast, and fluorescent optics. Principles of photomicrography. Classwork, 1 unit; laboratory, 1 unit. Extra fee required.

BIOL 401 General Microbiology (Units: 3)
Prerequisites: BIOL 230, BIOL 240, CHEM 233 with a grade of C- or better.
Morphology, physiology, genetics, molecular biology, evolution, and taxonomy of microorganisms; bacteria and viruses; importance of microbes in biotechnology, ecology, and public health.

BIOL 402GW General Microbiology Laboratory - GWAR (Units: 3)
Prerequisites: Restricted to Biology majors; ENG 214 with a grade of C- or better, 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. Composition, 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 401, BIOL 402GW, BIOL 355, 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, BIOL 402GW with a grade of C- or better, or consent of instructor. Intended for biology majors.  
Molecular aspects of virus structure, genetics, reproduction, and infection. Bacterial, animal, and plant viruses. (Plus-minus letter grade only)

BIOL 425 Emerging Diseases (Units: 3)  
Prerequisites: BIOL 230, BIOL 240, BIOL 355 or BIOL 401 or BIOL 350, CHEM 130.  
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: BIOL 401 with a grade of C or better, consent of instructor. Preference to graduating Biology seniors and majors requiring this course. Principles of infection, immunity, and characterization of medically important microbial agents.

BIOL 431 Medical Microbiology Laboratory (Units: 2)  
Prerequisites: BIOL 401, BIOL 402GW with a grade of C- or better, BIOL 430 (may be taken concurrently), consent of instructor. Enrollment priority for B.S. Biology majors.

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

BIOL 435 Immunology (Units: 3)  
Prerequisite: BIOL 350 or BIOL 401. 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 440 Ethical Issues in Science and Technology (Units: 3)  
Prerequisites: Upper division standing; ENG 214 or equivalent.

Ethical dimensions of science and technology. Conceptual and theoretical frameworks from the humanities and the life sciences. (This course is offered as BIOL 440 and ENGR 440. Students may not repeat the course under an alternate prefix.)

BIOL 442 Microbial Physiology (Units: 3)  
Prerequisites: BIOL 401, BIOL 402GW with a grade of C- or better, CHEM 349 or equivalent. Intended for Biology majors.

Function, biosynthesis, structure, and chemistry of cells and viruses; transport, chemotaxis, and energy metabolism; the regulation of growth rate and growth efficiency; mechanisms of viral and microbial differentiation.
BIOL 470 Natural History of Vertebrates (Units: 4)
Prerequisites: BIOL 230, 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. Classwork, 2 units; laboratory, 1 unit; fieldwork, 1 unit. Extra fee required.

BIOL 475GW Herpetology - GWAR (Units: 3)
Prerequisites: ENG 214 or equivalent with a grade of C- or better, BIOL 230, BIOL 240, or consent of instructor. Intended for Biology majors.
Evolution, classification, and distribution of amphibians and reptiles. The ecology and behavior of California species. Classwork, 2 units; laboratory and fieldwork, 1 unit. Extra fee required. (Plus/minus ABC/NC)

Course Attributes:
• Graduation Writing Assessment

BIOL 478GW Ornithology - GWAR (Units: 4)
Prerequisites: BIOL 230, BIOL 240. Intended for Biology majors.
Anatomy, physiology, behavior, distribution, classification, and evolution of birds; visits to the San Francisco Zoo, private aviaries and museums. Classwork, 2 units; laboratory, 1 unit; fieldwork, 1 unit. One weekend field trip required. Extra fee required. (Plus/minus ABC/NC)

Course Attributes:
• Graduation Writing Assessment

BIOL 482 Ecology (Units: 4)
Prerequisites: BIOL 230, 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. Classwork, 3 units; laboratory and fieldwork, 1 unit. Extra fee required.

BIOL 490 Ecology of Infectious Diseases (Units: 4)
Prerequisites: BIOL 230, 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. Classwork, 3 units; activity, 1 unit.

BIOL 492 Comparative Anatomy of Vertebrates (Units: 4)
Prerequisites: BIOL 230, BIOL 240. Intended for Biology majors.
Organ systems of selected vertebrate types. Classwork, 2 units; laboratory, 2 units. Extra fee required.

BIOL 500 Evolution and Diversity of Plants (Units: 4)
Prerequisites: BIOL 230, 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. Classwork, 2 units; laboratory, 2 units. Extra fee required.

BIOL 502 Biology of the Algae (Units: 3)
Prerequisites: BIOL 230, BIOL 240. Intended for Biology majors.
Collection, preservation, identification, and culturing of marine and freshwater algae. Comparative studies of morphology, life history, and ecology. Field trips. Classwork, 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, BIOL 240. Intended for Biology majors.
Groups of fungi including their classification, life cycles, morphology and development, and economic significance. Classwork, 2 units; laboratory, 1 unit; fieldwork, 1 unit. Extra fee required.

BIOL 505 Comparative Anatomy of Vascular Plants (Units: 4)
Prerequisites: BIOL 230, 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. Classwork, 2 units; laboratory; 2 units. Extra fee required.

BIOL 508 Plants and Human Affairs (Units: 3)
Prerequisites: BIOL 230, 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. Classwork, 2 units; laboratory, 1 unit.

BIOL 514 Plant Taxonomy (Units: 5)
Prerequisites: BIOL 230, BIOL 240. Intended for Biology majors.
Principles of plant taxonomy including classification systems and phylogenetic relationships within the flowering plants; practice in identification and collecting. Classwork, 2 units; laboratory and fieldwork, 3 units.
(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, CHEM 130. Intended for Biology majors.
Plant physiology: 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, 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 - GWAR (Units: 4)
Prerequisites: ENG 214 or equivalent with a grade of C- or better, BIOL 230, BIOL 240. 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. Classwork, 2 units; laboratory, 1 unit; fieldwork, 1 unit. Extra fee required. (Plus/minus ABC/NC)

Course Attributes:
- Graduation Writing Assessment

BIOL 530 Conservation Biology (Units: 3)
Prerequisites: BIOL 230, BIOL 240, or consent of 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, BIOL 240.

Focuses on restoration of degraded habitats, with 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, BIOL 240, or consent of 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. Classwork, 3 units; laboratory, 1 unit. Extra fee required.

BIOL 550 Plant and Animal Interactions (Units: 4)
Prerequisites: BIOL 230, BIOL 240, an upper division course in ecology. Intended for Biology majors.

Interactions between animals and plants, including such general topics as herbivory, seed dispersal and predation, mycorrhizae, mimicry, myrmecochory, and the co-evolutionary processes that lead to such interactions. Classwork, 3 units; laboratory, 1 unit. Extra fee required. (Plus/minus letter grade only)

BIOL 555 Marine Invertebrate Zoology (Units: 4)
Prerequisites: BIOL 230, BIOL 240. Intended for Biology majors.

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

BIOL 556 Natural History of Marine Invertebrates (Units: 4)
Prerequisites: BIOL 230, BIOL 240, BIOL 555 recommended.

Investigation of concept of biodiversity using California coastal communities in local intertidal and nearshore habitats as a field laboratory. Field trips required. Classwork, 2 units; laboratory, 2 units. Extra fee required.

BIOL 570GW Biology of Fishes - GWAR (Units: 4)
Prerequisites: ENG 214 or equivalent with a grade of CR or C- or better, BIOL 230, BIOL 240, or consent of instructor. Intended for Biology majors.

Morphology, physiology, behavior, ecology, distribution, classification, and evolution of marine and freshwater fishes; California species. Classwork, 2 units; laboratory and fieldwork, 2 units. Two weekend field trips. 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.
Prerequisite for BIOL 572: Upper division standing or consent of instructor.

Presentation of student and faculty research, recent journal articles, and presentations 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 575 Fisheries Biology (Units: 3)
Prerequisite: BIOL 570GW or a course in ecology. Intended for Biology majors.

Principles and practices in fish ecology and population dynamics, fishing methods and economics, and fisheries management. Classwork, 2 units; laboratory and fieldwork, 1 unit. Extra fee required.

BIOL 577 Ecological and Environmental Modeling (Units: 4)
Prerequisites: BIOL 230, BIOL 240, or a course in ecology, MATH 199, or consent of instructor. Intended for Biology majors.

Theory and practice of mathematical and computer modeling of organisms, ecosystems, and their environment. Classwork, 3 units; laboratory, 1 unit. (Plus/minus letter grade only)

BIOL 580 Limnology (Units: 3)
Prerequisites: BIOL 230, BIOL 240, CHEM 215, CHEM 216. A course in ecology is recommended. Intended for Biology majors.

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

BIOL 582 Biological Oceanography (Units: 4)
Prerequisites: BIOL 230, BIOL 240. Intended for Biology majors.

Physical characteristics of oceans; biology of plankton and benthos, emphasizing production and food webs. Identification, sampling, and productivity measurements of marine organisms. Classwork, 3 units; laboratory and fieldwork, 1 unit. Extra fee required.

BIOL 584 Marine Microbial Ecology Laboratory (Unit: 1)
Prerequisite: CHEM 115.

Laboratory section covers methods of measuring microbial rate processes (growth, nutrient uptake, etc.) and assessment of cell concentration in situ; isolation and culture of microbes. Extra fee required.

BIOL 585 Marine Ecology (Units: 3)
Prerequisites: BIOL 230, BIOL 240. Intended for Biology majors.

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

BIOL 586 Marine Ecology Laboratory (Units: 2)
Prerequisites: BIOL 585 (may be taken concurrently).
Laboratory and fieldwork in marine ecology introducing students to 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. Extra fee required.

BIOL 600 Animal Behavior (Units: 3)
Prerequisites: BIOL 230, 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. Extra fee required. (Plus-minus letter grade only)

BIOL 607 Conservation and Management of Marine Mammals (Units: 3)
Prerequisites: BIOL 230, BIOL 240, 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, BIOL 230, or equivalents, or consent of 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, PHYS 121. Intended for Biology majors.
Integrative mechanisms; control systems in cardiovascular and respiratory physiology. Circulation; distribution and regulation of body fluids; digestive systems; metabolism.

BIOL 612GW Human Physiology Laboratory - GWAR (Units: 3)
Prerequisites: ENG 214 with a grade of C- or better, 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. Classwork, 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, BIOL 240. Intended for Biology majors.
Microscopic anatomy of tissues and organ systems of vertebrates. Classwork, 2 units; laboratory, 2 units. Extra fee required.

BIOL 615 Molecular Pathophysiology (Units: 3)
Prerequisites: BIOL 350, BIOL 355, 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, PHYS 121, or consent of 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 only; BIOL 350, BIOL 355, BIOL 212 or BIOL 612.
Biological processes underlying aging. Focus on the molecular mechanisms of aging, including specific animal models of aging, 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 only; 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: Restricted to Biology majors and Pre-health certificate students; BIOL 230, BIOL 240.

BIOL 621 Reproductive Physiology (Units: 3)
Prerequisites: BIOL 230, BIOL 240, BIOL 330, 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, BIOL 240, or consent of instructor, a course in physiology or endocrinology strongly recommended. 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 in non-human species.

BIOL 623 Pharmacology (Units: 3)
Prerequisites: BIOL 230, BIOL 240 with grades of C- or better, BIOL 612, CHEM 130.
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.)
**Biology**

**BIOL 625 Hematology (Units: 3)**
Prerequisite: One semester of college physiology. Intended for Biology majors.


**BIOL 627 Biophysics (Units: 3)**
Prerequisites: PHYS 121, CHEM 115, BIOL 230, or equivalents, or consent of 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, regulation of gene expression.

**BIOL 630 Animal Physiology (Units: 3)**
Prerequisites: BIOL 230, BIOL 240, CHEM 130. Intended for Biology majors.

The physiology of animals, including structure, function, and regulation of organ systems. Unifying principles and natural adjustments to stress.

**BIOL 631GW Animal Physiology Laboratory - GWAR (Units: 4)**
Prerequisite for BIOL 731: BIOL 630 or BIOL 612.
Prerequisites for BIOL 631GW: ENG 214 with a grade of C- or better;
BIOL 612 or BIOL 630. Intended for Biology majors.

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. Classwork, 2 units; laboratory 2 units. Extra fee required. (Plus/minus letter grading only)

**BIOL 638 Bioinformatics & Genome Annotation (Units: 4)**
Prerequisite for BIOL 738: BIOL 357 or consent of instructor.
Prerequisite for BIOL 638: BIOL 230 or consent of instructor.

Analyze and annotate a different chunk of genomic DNA. Results from this course will be incorporated into peer-reviewed publications, students listed as an author. (Plus/minus letter grade only)

**BIOL 640 Cellular Neurosciences (Units: 3)**
Prerequisites: BIOL 230, BIOL 240, CHEM 130, 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)**
Prerequisites: BIOL 328, BIOL 612, BIOL 620, BIOL 630. BIOL 640 is recommended. Intended for Biology majors.

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 652 Science Education Partners in Biology (Units: 4)**
Prerequisites: BIOL 230, BIOL 240, or one upper division biology course and consent of instructor.

Introduction to biology teaching and learning; engage in K-12 classroom teaching; examine understanding of biology, discuss science education literature, and analyze biology lessons and student learning. Classwork, 2 units; fieldwork, 2 units. Extra fee required.

**BIOL 699 Independent Study in Biology (Units: 1-3)**
Prerequisites: Senior standing in biology and consent 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 702 Biology of the Algae (Units: 3)**
Prerequisites: BIOL 230, BIOL 240. Intended for Biology majors.

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

**BIOL 710 Advanced Biometry (Units: 3)**
Prerequisite: BIOL 458.

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, letter), time and stress management. (Plus/minus letter grading only)

**BIOL 711 Immunoassays (Units: 3)**
Prerequisites: CHEM 349, BIOL 435 or equivalent (may be taken concurrently).

Principles and applications of antigen-antibody interactions, immunoassay design, and detection systems. Enzyme, luminescent and fluorescent assays, and their successful application in laboratory medicine or biological research are emphasized.
BIOL 714 Biomedical Enzymology (Units: 3)
Prerequisite: CHEM 349 or equivalent.

Fundamental knowledge of enzymes, cofactors, and enzyme kinetics. Laboratory and computer exercises focus on action and kinetics of enzymes commonly used in medical diagnosis and/or biotechnology research. Classwork, 2 units; laboratory, 1 unit. Extra fee required.

BIOL 716 Skills for Scientific Proposal Writing (Units: 3)
Prerequisites: Graduate standing and consent of instructor.

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

BIOL 723 Pharmacology (Units: 3)
Prerequisites: BIOL 230, BIOL 240 with grades of C- or better, BIOL 612, CHEM 130.

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 731 Animal Physiology Laboratory - GWAR (Units: 4)
Prerequisite for BIOL 731: BIOL 630 or BIOL 612.
Prerequisites for BIOL 631GW: ENG 214 with a grade of C- or better, BIOL 612 or BIOL 630. Intended for Biology majors.

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. Classwork, 2 units; laboratory 2 units. Extra fee required. (Plus/minus ABC/NC)

(BIOL 731/BIOL 631GW is an undergraduate/graduate level paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

Course Attributes:

- Graduation Writing Assessment

BIOL 732 Biology and Chemistry of Signaling Pathways (Units: 3)
Prerequisite: Classified graduate status or consent of instructor.

An interdisciplinary presentation of the mechanisms by which extracellular stimuli trigger intracellular biochemical reactions that lead to alterations in cellular function.

(This course is offered as BIOL 732 and CHEM 846. Students may not repeat the course under an alternate prefix.)

BIOL 737 Plant Metabolism (Units: 3)
Prerequisite: BIOL 525 or CHEM 340 or CHEM 349. Intended for Biology and Chemistry majors.

Plant metabolism: photosynthesis, cell wall biosynthesis, nitrogen, and sulfur metabolism, secondary plant products. Common metabolic pathways with an emphasis on functioning and regulation of these pathways in plants.

BIOL 738 Bioinformatics & Genome Annotation (Units: 4)
Prerequisite for BIOL 738: BIOL 357 or consent of instructor.
Prerequisite for BIOL 638: BIOL 230 or consent of instructor.

Analyze and annotate a different chunk of genomic DNA. Results from this course will be incorporated into peer-reviewed publications, students listed as an author. (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)
Prerequisite: Graduate or senior standing, or consent of instructor.

Preparation of biological and inorganic materials for scanning and transmission electron microscopy, x-ray microanalysis, EBSD, CL, operation of the electron microscope(s), and data interpretation. Classwork, 1 unit; laboratory, 3 units. Extra fee required.

(This course is offered as BIOL 741, CHEM 741, and ERTH 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, 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 consent of instructor.

Introduction to practical teaching strategies, science education theory and research, and scientific teaching to SF State graduate student scientists 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 756 Principles of Human Genetics (Units: 3)
Prerequisite: Upper division genetics course and consent of instructor.

Intended for graduate students in Biology and Genetic Counseling.

Inheritance, molecular genetics, cyto genetics, variation, mutation, family history, pedigree analysis, genetic risk calculation, quantitative traits, evolution and population genetics. (Plus/minus letter grade only)

BIOL 760 Cancer Biology (Units: 3)
Prerequisites: Classified graduate standing; CHEM 340 or CHEM 349, BIOL 350 or BIOL 401, BIOL 357, or consent of instructor.

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

BIOL 763 Molecular Biology of Cancer (Units: 2)
Prerequisites: Graduate standing, a course in biochemistry.

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

BIOL 765 Biomedical Immunology Advanced Topics (Units: 2)
Prerequisite: Graduate standing or consent of instructor.

Faculty direct and evaluate student presentations of seminars on selected advanced topics in clinical immunology.
BIOL 772 Molecular Methods in Medical Microbiology (Units: 4)
Prerequisites: Graduate standing; biochemistry and microbiology courses with laboratory, or consent of instructor.

Overview of clinically significant microorganisms, emphasizing functional roles of biological macromolecules in pathogenesis and genetic applications. Lab covers basic principles and current molecular techniques used in model microbes. Classwork, 2 units; laboratory, 2 units. Extra fee required.

BIOL 774 Nucleic Acid Probe Methods: Biotechnology Applications (Units: 3)
Prerequisite: Graduate standing in biology or consent of instructor.

Basic concepts and applications of modern nucleic acid technologies in diagnosis, therapeutics, and biotechnology. Classwork; 1 unit; laboratory, 2 units. (Plus-minus letter grade only)

BIOL 775 Biomedical Microbiology Advanced Topics (Units: 2)
Prerequisite: Graduate standing or consent of instructor.

Primary scientific articles on important human microbial diseases and a centenary perspective of scientific discovery in microbiology are emphasized. Students are required to participate in article presentations and discussion.

BIOL 781 Biomedical Virology Foundations (Units: 3)
Prerequisite: Graduate standing or consent of instructor.

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

BIOL 782 Developmental Biology (Units: 3)
Prerequisites for BIOL 782: Graduate standing; BIOL 350, BIOL 355 or equivalents with grades of C- or better; or consent of instructor.
Prerequisites for BIOL 382: BIOL 350, BIOL 355 with grades of C- or better. Intended for Biology and Biochemistry majors.

Early embryonic development: exploration of the molecular genetic basis for tissue differentiation. Gene regulation, chromatin, sex determination, oncogenesis, aging, and pattern formation. Extra fee required. (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 consent of instructor.

Topic to be specified in Class Schedule. May be repeated as topics vary.

BIOL 792 Molecular Virology (Units: 4)
Prerequisite: Graduate standing or consent of instructor.

Virology laboratory covering the growth and detection of viruses. Techniques include the propagation and titration of viruses in cell culture as well as the detection of viral infections by immunochemical and nucleic acid-based techniques. Classwork, 2 units; laboratory, 2 units.

BIOL 793 Advances in Biomedical Hematology (Units: 2)
Prerequisite: Graduate standing or consent of instructor.

Topic to be specified in Class Schedule. May be repeated as topics vary.

BIOL 800 Mushroom Taxonomy (Units: 3)
Prerequisites: Graduate or senior standing; BIOL 504 or equivalent; or consent of instructor.

Morphology, microscopic anatomy, taxonomy: biochemical and cytological aspects, ecology and artificial cultivation of the macroscopic fungi. Classwork, 2 units; laboratory and fieldwork, 1 unit. Extra fee required.

BIOL 801 Population Genetics (Units: 3)
Prerequisite: Graduate standing or consent of instructor.

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

BIOL 802 Advanced Topics in Biotechnology (Units: 2)
Prerequisite: Graduate standing in Biology and consent of instructor.

Examination of the current topics in biotechnology, pharmaceutical, and clinical research industry. May be repeated as topics vary.

BIOL 803 Core Concepts of Biotechnology (Units: 3)
Prerequisite: CHEM 340 or BIOL 355 or BIOL 357, or equivalent background with consent of 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: Graduate standing in Biology and consent of instructor.

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

BIOL 805 Evolutionary Genetics (Units: 4)
Prerequisites: Graduate or senior standing; BIOL 355; or consent of instructor.

Principles of evolutionary genetics, including an emphasis on evolutionary quantitative genetics, molecular population genetics, molecular evolution and genomics. Classwork, 2 units; laboratory, 2 units. Extra fee required.

BIOL 814 Plant Taxonomy (Units: 5)
Prerequisites: BIOL 230, BIOL 240. Intended for Biology majors.

Principles of plant taxonomy including classification systems and phylogenetic relationships within the flowering plants; practice in identification and collecting. Classwork, 2 units; laboratory and fieldwork, 3 units. (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 consent of instructor.

Methods and techniques of phylogenetic inference. Parsimony, maximum likelihood, quantitative phylogenetic analysis, and comparative methods. Molecular data in evolution. Classwork, 3 units; laboratory, 1 unit. Extra fee required. (Plus-minus letter grade only)
BIOL 818 Molecular Techniques in Evolution and Ecology (Units: 4)
Prerequisite: BIOL 355 or equivalent and consent of instructor.

Molecular techniques commonly used in the fields of evolutionary biology and ecology. PCR and direct DNA sequencing. Classwork, 2 units; laboratory, 2 units. Extra fee required.

BIOL 821 Fire Ecology (Units: 3)
Prerequisites: Graduate or senior standing; BIOL 529GW; or consent of instructor.

Role of fire as an environmental factor in the life histories and succession of plants and/or animals. Classwork, 2 units; laboratory, 1 unit. Extra fee required.

BIOL 830 Advanced Conservation Biology (Units: 3)
Prerequisites: Graduate standing; BIOL 530; or consent of instructor.

Theory and practice of nature conservation; traditional resource management; new theory of the conservation of small populations. Classwork, 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 consent of instructor.
Prerequisites for BIOL 332: BIOL 230, BIOL 240, BIOL 355.

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 standing in Biology, a course in ecology.

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

BIOL 843 Population Biology (Units: 3)
Prerequisites: Graduate or senior standing, a course in genetics, ecology, biometry.

Modern concepts of structure, organization, and evolution of plant and animal populations. Genetical, ecological, evolutionary, and theoretical approaches to the study of populations.

BIOL 844 Research Skills - GWAR (Units: 3)
Prerequisite for BIOL 844: Graduate standing or consent of instructor.
Prerequisites for BIOL 344GW: ENG 214 or equivalent with a grade of credit or C- or better, BIOL 230, BIOL 240, and consent of instructor.

Practical skills for successfully conducting undergraduate research. Focus on experimental design, critical review of literature, effective oral and written scientific presentation, and development of research plan. (Plus/minus ABC/NC)

(BIOL 844/BIOL 344GW is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

Course Attributes:
- Graduation Writing Assessment

BIOL 848 Behavioral Ecology (Units: 3)
Prerequisite: Graduate standing or consent of instructor.

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

BIOL 849 Bioethics (Units: 3)
Prerequisite for BIOL 849: Graduate standing or consent of instructor.
Prerequisite for BIOL 349: Upper division standing.

Biomedical ethics: experiments on humans and laboratory animals, genetic engineering, in vitro fertilization, fetal research, abortion, the health care system, organ transplants, death and dying.

(BIOL 849/BIOL 349 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

Course Attributes:
- UD-B: Physical Life Science
- Social Justice

BIOL 860 Advances in Biology Education Research (Units: 2)
Prerequisite: Graduate standing or consent of instructor.

Students will 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 consent of instructor.

Topic to be specified in Class Schedule. May be repeated as topics vary.

BIOL 862 Advances in Ecology and Systematic Biology (Units: 2)
Prerequisite: Graduate standing or consent of instructor.

Topic to be specified in Class Schedule. May be repeated as topics vary.

BIOL 863 Advances in Marine Biology (Units: 2)
Prerequisite: Graduate standing or consent of instructor.

Topic to be specified in Class Schedule. May be repeated as topics vary.

BIOL 864 Advances in Microbiology (Units: 2)
Prerequisites: Graduate standing and consent of instructor.

Topic to be specified in Class Schedule. May be repeated as topics vary.
BIOL 865 Advances in Physiology and Behavioral Biology (Units: 2)
Prerequisite: Restricted to graduate students in Biology or consent of instructor.

Topic to be specified in Class Schedule. May be repeated as topics vary.

BIOL 871 Colloquium in Microbiology, Cell and Molecular Biology (Units: 2)
Prerequisite: Graduate standing or consent of instructor.

Presentation of student and faculty research, recent journal articles, and presentations by outside speakers. Does not fulfill 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.
Prerequisite for BIOL 572: Upper division standing or consent of instructor.

Presentation of student and faculty research, recent journal articles, and presentations 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 881 Seminar: Cell and Molecular Biology (Unit: 1)
Prerequisites: Graduate standing and consent of instructor.

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

BIOL 883 Seminar in Marine Biology (Units: 2)
Prerequisite: Graduate standing or consent of instructor.

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

BIOL 890 Cooperative Internship (Units: 2-3)
Prerequisite: Graduate standing.

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

BIOL 891 Biomedical Research Design (Units: 2)
Prerequisite: Must have fulfilled the GET requirement and have a specific research topic approved by a mentor.

Exercises encompass the elements of biomedical laboratory science research proposals: 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)
Prerequisite: BIOL 896, consent of instructor, approval of Advancement to Candidacy (ATC) and Culminating Experience (CE) forms by Graduate Studies.

Supervised independent and original laboratory or field investigation. Guidelines available at the biology department office. Advancement to Candidacy and Proposal for Culminating Experience Requirement forms must be approved by Graduate Studies before registration. (CR/NC grading only)

BIOL 896 Directed Reading (Unit: 1)
Prerequisites: Approval of 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.

BIOL 897 Research (Units: 1-6)
Prerequisites: Completed undergraduate major in biology and classified status. Independent and original laboratory or field investigation under supervision of a faculty member. May be repeated.

BIOL 898 Master's Thesis (Units: 4)
Prerequisites: Consent of instructor and approval of Advancement to Candidacy (ATC) for the Master of Arts in Biology and Culminating Experience (CE) forms by Graduate Studies.

Advancement to Candidacy and Proposal for Culminating Experience Requirement forms must be approved by the Graduate Division before registration.