The General Education Requirement in the Biological Sciences

All students are required to complete at least two quarters of Biological Sciences course work to satisfy the General Education requirement in the Biological Sciences. The goal is to provide students of all majors and academic interests with a broad foundational understanding of biology and an opportunity to focus on a specific area of interest within the discipline. The requirement should be completed by the end of the second year.

Most students choose one of the following options to meet the General Education requirement in the Biological Sciences. For other options, see Specific General Education Requirement for Certain Majors.

1. A two-quarter General Education Sequence for non–Biological Sciences majors. Students choose one of two options:
   - BIOS 10130 Principles of Biology or BIOS 10140 Inquiry-based Exploration of Biology followed by any Topics course (course numbers BIOS 11125-BIOS 16120 and BIOS 27721-27723).
   - A two-quarter sequence (BIOS 10500 Metabolism and Exercise - BIOS 10501 Systems of the Human Body or BIOS 10602 Multiscale Modeling of Biological Systems I - BIOS 10603 Multiscale Modeling of Biological Systems II).

   Note: Students cannot receive credit for both BIOS 10130 Principles of Biology and BIOS 10140 Inquiry-based Exploration of Biology.

2. The first two courses of the Health Professions Preparation Sequence for Non-Majors (BIOS 20170 Microbial and Human Cell Biology through BIOS 20175 Biochemistry and Metabolism) for students interested in completing the requirements for application to graduate schools in the health professions but not majoring in Biological Sciences or Biological Chemistry. Note: BIOS 20171 requires concurrent enrollment with BIOS 20172 in the second quarter of the sequence.

3. The first two courses in a Fundamentals Sequence for Biological Sciences majors: BIOS 20153 Fundamentals of Ecology and Evolutionary Biology and BIOS 20151 Introduction to Quantitative Modeling in Biology (Basic) or BIOS 20152 Introduction to Quantitative Modeling in Biology (Advanced). Note: Non-majors may not use BIOS 20151 or BIOS 20152 as a topics course.

4. Completion of three quarters of the Advanced Biology Fundamentals Sequence. Students with a score of 4 or 5 on the AP Biology test who complete the first three quarters of an Advanced Biology Fundamentals Sequence will be awarded a total of two quarters of credit to be counted toward the general education requirement in the biological sciences and three quarters of credit for Biological Sciences Fundamentals courses. For more information about the Advanced Biology Fundamentals Sequence, see the Biological Sciences Program of Study page in this catalog.

Advanced Placement Credit

For students who do not plan to prepare for the health professions or pursue a major that requires specific courses for the general education requirement, a score of 4 or 5 on the AP Biology test confers credit for BIOS 10130 Principles of Biology or BIOS 10140 Inquiry-based Exploration of Biology. These students complete the general education requirement in the Biological Sciences with either one or two Topics courses, depending on how the requirements in the mathematical and physical sciences are met; students should contact their College adviser for details.

General Education Sequences for Non-Biological Sciences Majors

Foundational Courses for Non-Majors

BIOS 10130. Principles of Biology. 100 Units.

What is life? How does it work and evolve? This course uses lectures, student-centered interactive learning in the lab, assigned readings from both the popular press and primary scientific literature, and directed writing exercises to explore the nature and functions of living organisms, their interactions with each other, and their environment.

Instructor(s): Staff Terms Offered: Autumn Spring Summer Winter

Multiple sections of BIOS 10130 Principles of Biology are taught throughout the year. Sections are taught from a different perspective based upon the specialty of the instructor. Students should register for the section that best suits their interests based upon the descriptions below:

A. Microbes and Immunity. This section covers the most basic concepts in biology, such as life, macromolecules, cells, energy, metabolism, evolution, and genomics, as well as human anatomy and physiology, drawing examples from microbiology and immunology to tie these basic concepts together. The impact of our interactions with microorganisms in our evolution is highlighted in many ways. Hands-on laboratories, readings, and discussion sessions complement lectures. B. Fineschi. Autumn, Winter, Spring. L.
B. Evolution. What is life? How does it work and evolve? This course uses student-centered interactive learning in the lab, assigned readings from both the popular press and primary scientific literature, and directed writing exercises to explore the nature and functions of living organisms, their evolution, and their interactions with each other. A. Hunter. Autumn, Spring, L.

C. Ecology and Evolution. This course focuses on the interaction of organisms with their environment and evolutionary processes that lead to diversity and adaptation. We will examine biological processes at the cellular and organismal levels across a wide range of organisms, considering their ecological similarities and differences in an evolutionary framework. Population and ecosystem levels will be examined to promote understanding of the importance of diversity in ecosystem health and the impacts of an ever increasing human population. E. Larsen. Winter, L.

BIOS 10140. Inquiry-based Exploration of Biology. 100 Units.
In this course students will be able to conduct their own research projects to experience how biologists frame questions and test hypotheses. This inquiry-based approach permits students to learn fundamental biological principles while participating in scientific endeavors and expanding our knowledge of living systems. Classes will take place in the lab, integrating lectures, discussions, and experiments in active sessions, thus eliminating the separation between theory and practice. Students will also have an opportunity to develop communication skills during the quarter, presenting their proposals and results to their peers and instructors, in seminar or symposium formats. Each course instructor will focus their section on a different major problem in the biological sciences that will frame the students’ research questions.

Instructor(s): Staff Terms Offered: Autumn Spring Winter
Note(s): Equivalent to BIOS 110.

Multiple sections of BIOS 10140 Inquiry-based Exploration of Biology are taught throughout the year. Sections are taught from a different perspective based upon the specialty of the instructor. Students should register for the section that best suits their interests based upon the descriptions below:

A. Neurobiology. What is the relationship between an organism’s genetic makeup (genotype) and its characteristics (phenotype)? How do genetics and environment influence the working of the brain? Embedded within these two Grand Challenges are questions central to understanding the biological basis of organismal behavior in a changing environment. The answers to these questions have significant implications for human health and society. This course aims to explore these Grand Challenges by examining the genetic, neurobiological, and environmental mechanisms shaping complex behaviors. Through the development of an inquiry-based research project, complemented by short lectures and discussions of the scientific literature, students will be introduced to fundamental biological principles, the logic of scientific reasoning and experimental design, and methods for collecting, evaluating, and communicating scientific evidence. M. McNulty. Autumn, Spring, L.

B. Microbiology. Human beings are an ecosystem, with multiple types of microbes living in various niches within the human body. Together, these microbes form our “microbiomes.” The microbiome has profound and yet poorly understood impacts on human health. How is our microbiome established, and how does it change in response to the chemicals in our environments? Using gut bacteria grown in the lab, we will explore responses of individual bacteria and bacterial communities to their dynamic environment, focusing on the changes elicited by the foods and chemicals that we eat. Foods alter the dynamics of the bacteria that inhabit our bodies, particularly in our guts. The foods we eat contain nutrients, microbes (some pathogenic), and a range of chemicals with natural antimicrobial properties. Through guided and original research projects, students will gain an insight into the effects of diet on the microbiome, as well as training in scientific reasoning, experimental design, and methods for collecting, evaluating, analyzing, and communicating scientific data. In the context of these studies, we will also examine biological systems at the molecular, cellular, and organismal levels and ecosystems through short lectures and discussions of the scientific literature. N. Bhasin. Spring, L.

C. Ecology. Biodiversity encompasses all different biological organisms in our planet, from viruses, microorganisms, plants, fungi, invertebrates, and vertebrates. Interactions among these organisms form a complex and dynamic network crucial for our planet. How does urbanization, a process transforming ecosystems all across our planet, affect biodiversity? This fundamental question has been poorly studied, specifically estimations of species diversity in city habitats and characterization of urban biological communities, both central to our understanding of how urbanization impacts crucial ecological functions such as pollination, water filtration, and waste decomposition. In this course, students will develop their own research project exploring components of the biodiversity in our neighborhood, e.g., invertebrate or plant communities, and their interactions. Students will identify local habitats, collect data and specimens to document species diversity, and address research questions regarding local communities, such as: Do natural areas have more or less diversity than developed areas? Or, is the number of exotic species greater, equal, or smaller than native species in parks around our neighborhood? During the course, students will review fundamental biological concepts through analysis of the DNA and genetic information of the organisms they collect, and through observations of their cells and tissues. Students will also learn about their reproductive mechanisms, search for information about their evolution, and explore their populations, trophic networks, and community structures. Finally, this course will provide students with an opportunity to experience the process of scientific research, allowing them to
develop their own scientific questions, test hypotheses, identify legitimate sources of information, and analyze data. O. Pineda. Autumn, Winter. L.

D. Cell and Developmental Biology. This course asks the fundamental question: Why are some organisms able to regenerate tissues, organs, and body parts while others (like us) cannot? This course will show how scientists probe this question by using a lab model animal with incredible regenerative capacity: planaria. In this system we can ask how single cells lead to complex organisms with multiple tissue types, what happens in the case of injury or removal of those tissues, and what genes are required for the repair and regeneration of tissues. Students will develop their own research questions and propose their own experiments designed to answer those questions. Throughout this process, students will learn about fundamental principles in biology, experimental design and analysis, and scientific communication, which will culminate in writing and presenting their own research proposal. A. Brock. Winter. L.

E. Developmental Biology and Aging. Why do humans grow old, and is death inevitable? In this course we will explore the causes of aging and age-related phenotypes and investigate whether aging is genetically programmed, an unavoidable effect of metabolism, or an evolutionary consequence of natural selection. Students will explore topics including gene regulation, cell function, developmental biology, regeneration, aging, and evolution in three-hour sessions that combine short lecture segments, group work, discussion, and hands-on research. Experimental work will focus on a model system: a small worm named C. elegans that has been used by researchers to probe how cells and organisms age, and whether lifespan can be increased. Students will propose a research question concerning lifespan extension of C. elegans and will design their own experimental protocol to test their hypothesis using microscopy, PCR, sequence analysis, and statistics, and communicate their findings to the class in the form of a presentation P. Smith. Autumn, Winter. L.

F. Microbiology. Infectious disease and antimicrobial resistance to therapies have had a tremendous impact on humanity. With so many pathogens that can harm humans, including certain bacteria, viruses, fungi, and protists, this begs the fundamental question: Can humans ever be free from infectious disease? Despite the many technological and medical advances in the last century, humans have been successful in eradicating only two infectious diseases: smallpox (human) and rinderpest (cattle). Why have we not been more successful? What approaches do we currently have and how effective are they? What approaches should we strive for? In this course, students will learn about infectious diseases, the pathogens that cause them, and the phenomenon of antimicrobial resistance. The course will dive into the characteristics of these pathogens and what makes them unique. In groups, students will undertake a research project focused on the theme of antibiotic resistance. In addition, students will study the effects of antimicrobials examining susceptibility and resistance. Within the course, students will learn about the various strategies that pathogens have for survival, as well as how evolutionary mechanisms and environment have influenced these strategies. Complemented with lectures, students will learn about the scientific method, develop and test hypotheses, navigate scientific literature, and analyze data. R. Bednarz. Winter. Spring. L.

TOPICS COURSES FOR NON-MAJORS

The courses that follow have a prerequisite of BIOS 10130 Principles of Biology, or BIOS 10140 Inquiry-based Exploration of Biology, or a score of 4 or 5 on the AP Biology test. Attendance is required at the first class to confirm enrollment. Students who choose to complete only one general education course in the mathematical sciences may take a second Topics course as part of the general education requirements.

BIOS 11125. Life Through a Genomic Lens. 100 Units.
The implications of the double helical structure of DNA triggered a revolution in cell biology. More recently, the technology to sequence vast stretches of DNA has offered new vistas in fields ranging from human origins to the study of biodiversity. This course considers a set of these issues, including the impact of a DNA perspective on the legal system, on medicine, and on conservation biology.
Instructor(s): A. Turkewitz, M. Nobrega Terms Offered: Winter
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.
Equivalent Course(s): ENST 12402

BIOS 11136. Introduction to Complex Trait Genetics. 100 Units.
The goal of the course is to provide a basic understanding of how genetics affect complex diseases, like asthma and depression. We will cover differences between complex disorders and Mendelian disorders, like Huntington’s. We will summarize how geneticists use big data and machine learning to learn about the biology of complex diseases. We will also cover genetic predictions for complex traits, including their potential value for disease prevention and their potential peril for traits like education attainment. Students will read news articles and accessible excerpts from the literature, and will learn how to interpret genetics results in popular media and to understand precision treatment.
Instructor(s): X. Liu and A. Dahl Terms Offered: Autumn
Prerequisite(s): BIOS 10130 or BIOS 10140; NO BIOLOGICAL SCIENCES MAJORS AND NO NON-BIOLOGY PRE-MEDS, except by petition.

BIOS 11137. Phenotypes and Genotypes. 100 Units.
This course discusses how visible and functional characteristics we see in ourselves can be traced back to the sequences within our genomes. We will look at genetics through different lenses, starting with the gene as a
unit of inheritance and expanding to the gene as a protein-coding unit. Additionally, we will look at different disease phenotypes and trace their molecular basis to the chromosomal or sequence level. We will also discuss more complicated traits that are governed by multiple genes. Through all of this, we will cover topics including classical and modern approaches to genetics, genomics, genetic testing, evolution, and emerging technologies. We recommend you use the suggested textbook on human heredity, but we will provide readings from popular and scientific press to complement the textbook. This course will be a traditional, lecture-based course with assessments based on exams and problem sets.

Instructor(s): A. Brock; B. Fineschi
Terms Offered: Spring
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS AND NO NON-BIOLOGY PRE-MEDS, except by petition.

BIOS 11140. Biotechnology for the 21st Century. 100 Units.
This course is designed to provide a stimulating introduction to the world of biotechnology. Starting with an overview of the basic concepts of molecular biology and genetics that serve as a foundation for biotechnology, the course will segue into the various applied fields of biotechnology. Topics will include microbial biotechnology, agricultural biotechnology, biofuels, cloning, bioremediation, medical biotechnology, DNA fingerprinting and forensics. The goal of this course is to provide the Biology non-majors with an appreciation of important biotechnology breakthroughs and the associated bioethics issues.
Instructor(s): N. Bhasin
Terms Offered: Autumn Winter
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

BIOS 12114. Nutritional Science. 100 Units.
This course examines the underlying biological mechanisms of nutrient utilization in humans and the scientific basis for setting human nutritional requirements. The relationships between food choices and human health are also explored. Students consider how to assess the validity of scientific research that provides the basis for advice about how to eat healthfully. Class assignments are designed to help students apply their knowledge by critiquing their nutritional lifestyle, nutritional health claims, and/or current nutrition policy issues.
Instructor(s): P. Strieelman
Terms Offered: Autumn Spring Summer
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

BIOS 12115. Responses of Cardiopulmonary System to Stress. 100 Units.
This course is designed to provide students an overview of basic concepts involved in the functioning of cardiopulmonary vascular systems. Special emphasis will be given to different regulatory mechanisms working at the cell, tissue and organ levels to control the systems functioning during stress conditions. We also discuss recent topics related to molecular basis of adaptation and drugs designed to treat mal-adaptive changes taking place in the heart and lungs (vessels) subjected to various-types of pathological stresses. Instructors, who are both actively engaged in research to understand molecular basis of cardiopulmonary vascular diseases, take this course beyond the knowledge of standard textbook content.
Instructor(s): M. Gupta, Y. Fang
Terms Offered: Spring
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

BIOS 12116. The Human Body in Health and Disease. 100 Units.
This course is designed to provide an overview of physiological organ systems under different states of health and disease. A comprehensive tour through the human body will take students through the anatomy and functioning of several systems including, but not limited to, the cardiovascular, respiratory, nervous, renal, gastrointestinal, and immune systems. We will examine each of these systems under normal conditions and from the perspective of disease. A variety of pathological conditions including diabetes, heart and kidney diseases, neurodegenerative conditions, and autoimmune diseases, will be covered with an emphasis on how many diseases involve multiple organ systems.
Instructor(s): M. McNulty
Terms Offered: Autumn
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

BIOS 12117. The 3.5 Billion Year History of the Human Body. 100 Units.
This course looks at the structure, function, and deep history of the human body. Each major organ and system of the body is explored from perspectives of anatomy, paleontology, and developmental genetics to reveal the deep history of the body and our connections to the rest of life on the planet.
Instructor(s): N. Shubin
Terms Offered: Spring
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.
Note(s): Due to significant overlap of course content, students may register for only one of PHSC 11000, BIOS 12117, or GEOS 13900/BIOS 13123

BIOS 12121. Physiology in Extreme Environments. 100 Units.
Humans live nearly everywhere, including arid deserts, the tops of mountains, and frigid arctic tundra. We have also expanded our reach to include the bottom of the ocean and the International Space Station. Our bodies’ ability to make physiologic adaptations allows us to survive in each of these environments. Physiology
in Extreme Environments will enhance your understanding of how your body reacts to stressors such as high altitude, diving, spaceflight, isolation, and more. Discussion topics will include a review of the cardiovascular and respiratory systems, exercise physiology, and cerebral blood flow. We will also discuss the physiology of sleep and fatigue. This knowledge will then be used to explain how life support environments work and how we survive in dangerous environments.

Instructor(s): K. Ruskin, A. Garcia, A. Clebone Terms Offered: Winter
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

**BIOS 13111. Natural History of North American Deserts. 100 Units.**
This lecture course focuses on the ecological communities of the Southwest, primarily on the four subdivisions of the North American Desert, the Chihuahuan, Sonoran, Mohave, and Great Basin Deserts. Lecture topics include climate change and the impact on the flora and fauna of the region; adaptations to arid landscapes; evolutionary, ecological, and conservation issues in the arid Southwest, especially relating to isolated mountain ranges; human impacts on the biota, land, and water; and how geological and climatic forces shape deserts.

Instructor(s): E. Larsen Terms Offered: Spring
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

**BIOS 13112. Natural History of North American Deserts; Field School. 100 Units.**
This lecture/lab course is the same course as BIOS 13111, but includes a lab section preparatory to a three-week field trip at end of Spring Quarter, specific dates to be announced. Our goal in the lab is to prepare proposals for research projects to conduct in the field portion of this course. Field conditions are rugged. Travel is by fifteen-passenger van. Lodging during most of this course is tent camping on developed campsites.

Instructor(s): E. Larsen Terms Offered: Spring
Prerequisite(s): Consent of instructor. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

**BIOS 13123. Biological Evolution. 100 Units.**
This course is an introduction to evolutionary processes and patterns in present-day organisms and in the fossil record and how they are shaped by biological and physical forces. Topics emphasize evolutionary principles. They include DNA and the genetic code, the genetics of populations, the origins of species, and evolution above the species level. We also discuss major events in the history of life, such as the origin of complex cells, invasion of land, and mass extinction. This course is part of the College Course Cluster program: Climate Change, Culture and Society. (L)

Instructor(s): D. Jablonski Terms Offered: Winter
Prerequisite(s): BIOS 10130 or BIOS 10140
Note(s): No Biological Sciences majors except by petition to the BSCD Senior Advisers. Due to significant overlap of course content, students may register for only one of PHSC 11000, BIOS 12117, or GEOS 13900/BIOS 13123. Students using this course for credit in the GEOS or ENSC major register for GEOS 27300; additional work, including a term paper, will be required.
Equivalent Course(s): GEOS 13900

**BIOS 13128. Plant-Animal Interactions. 100 Units.**
In this course we investigate the ecological interactions between plants and animals, and their evolution. Through readings and discussion we explore herbivory and mutualisms (pollination, seed dispersal). How do plants defend themselves against herbivores? How have plants and their seed dispersers, pollinators, and predators co-evolved?

Instructor(s): A. Hunter Terms Offered: Autumn
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

**BIOS 13132. Ecology in the Anthropocene. 100 Units.**
This course emphasizes basic scientific understanding of ecological principles that relate most closely to the ways humans interact with their environments. It includes lectures on the main environmental pressures, notably human population growth, disease, pollution, climate change, habitat destruction, and harvesting. We emphasize the ongoing impacts on the natural world, particularly causes of population regulation and extinction and how they might feedback on to humans. Discussion required.

Instructor(s): T. Price Terms Offered: Autumn
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.
Equivalent Course(s): CEGU 13132, ENST 13132

**BIOS 13134. It’s Not Easy Being Green: An Introduction to Plant Biology. 100 Units.**
During this course students will obtain a broad tour of plant biology as we explore the evolution, reproduction, physiology, genetics, and ecology of plants. We will also explore the importance of plants to human society. Emphasis will also be placed on understanding scientific research - from experimental design to data analysis and future implications. The course will feature a selection of readings from diverse perspectives about plants, their biology, and their cultural significance. This course will encourage students to use their strengths and
are altered in cancer cells. The concept of genes that cause cancer (oncogenes) and genes that deter cancer (tumor suppressor genes) is central to understanding cancer. Cancer cells, as well as how cancer cells can acquire the ability to attract blood vessels (angiogenesis) and to evade the immune system (immunoevasion), are topics included in the course.

**BIOS 13140. The Public and Private Lives of Insects. 100 Units.**
This course examines the ecology and evolution of insects, from their early evolution over 350 million years ago to their adaptations that allow them to exploit nearly every habitat on earth and become the most diverse animal group on the planet. We explore the basic biology of insects that have allowed them to become the largest group of animals on the planet, making up approximately 1.5 million of the 2 million described species.

**BIOS 13142. From Fossils to Fermi's Paradox: Origin and Evolution of Intelligent Life. 100 Units.**
The course approaches Fermi's question, "Are we alone in the universe?", in the light of recent evidence primarily from three fields: the history and evolution of life on Earth (paleontology), the meaning and evolution of complex signaling and intelligence (cognitive science), and the distribution, composition and conditions on planets and exoplanets (astronomy). We also review the history and parameters governing extrasolar detection and signaling. The aim of the course is to assess the interplay between convergence and contingency in evolution, the selective advantage of intelligence, and the existence and nature of life elsewhere in the universe - in order to better understand the meaning of human existence.

**BIOS 13253. Apes and Human Evolution. 100 Units.**
This course is a critical examination of the ways in which data on the behavior, morphology, and genetics of apes have been used to elucidate human evolution. We emphasize bipedalism, hunting, meat eating, tool behavior, food sharing, cognitive ability, language, self-awareness, and sociability. Visits to local zoos and museums, film screenings, and demonstrations with casts of fossils and skeletons are required.

**BIOS 14112. Workings of the Human Brain: From Brain to Behavior. 100 Units.**
This course examines how the brain generates behavior. Topics include the organization of the nervous system; the mechanisms by which the brain translates external stimuli into electrical and chemical signals to initiate or modify behavior; and the neurological bases of learning, memory, sleep, cognition, drug addiction, and neurological disorders.

**BIOS 14117. The Science and Art of Vision. 100 Units.**
Why does a work of art evoke certain perceptual sensations or emotions? To what degree are these experiences shared or unique between individuals? This course will explore how scientific inquiry has contributed to our understanding of visual system function and our perception of the visual arts. We will evaluate hypotheses about the evolution of human vision and the impact of genetic and structural anomalies on perception. We will investigate how mechanisms of visual information processing influence the perception of art and how artists can exploit techniques that interface with the visual system to create striking impressions. The goal of this course is to enhance student appreciation for both the neuroanatomical and subjective bases for our experience of the visual arts.

**BIOS 15115. Cancer Biology: How Good Cells Go Bad. 100 Units.**
This lecture/discussion course examines the multi-step process by which normal cells become malignant cancer cells. Topics include how defects in the regulation of proliferation, differentiation, and apoptosis can occur in cancer cells, as well as how cancer cells can acquire the ability to attract blood vessels (angiogenesis) and to invade other organ systems (metastasis). We emphasize the study of signal transduction pathways and how they are altered in cancer cells. The concept of genes that cause cancer (oncogenes) and genes that deter cancer (tumor suppressor genes) is central to understanding cancer.
suppressor genes) is discussed. New disease treatments that target specific molecular defects within cancer cells are reviewed.

Instructor(s): M. Villereal Terms Offered: Spring Winter
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

BIOS 15126. Biology and Epidemiology of Cancer. 100 Units.
This course focuses on an introduction to cancer. From defining what cancer is to providing a biological perspective on how cancer arises and further progresses as a disease. The course will additionally focus on the influences of genetics and environmental factors in contributing to specific types of cancer. A brief analysis of the epidemiology of specific types of cancer will be discussed in addition to providing an overview on the traditional and emerging cancer therapeutics. The course will also provide a perspective on the psychological and societal impacts of cancer and how this continues to evolve.

Instructor(s): R. Bednarczyk Terms Offered: Spring
Prerequisite(s): BIOS 10130 or BIOS 10140.
Note(s): NO BIOLOGICAL SCIENCES MAJORS AND NO NON-BIOLOGY PRE-MEDS, except by petition.

BIOS 15127. Plants, Pathogens, and People. 100 Units.
Students will explore the major plant disease causing pathogens and how scientists and farmers are working to protect our food supply. Students will explore the biology of the major groups of disease-causing microorganisms (bacteria, fungi, oomycetes, viruses, and nematodes). We will also learn how plants are protected from infection - including protection from plant immunity, genetic improvement, and disease management practices. Additionally, we will discuss how plant pathogens have and continue to shape society - from the Irish Potato Famine to modern day disease epidemics. Emphasis will be placed on understanding scientific research in the context of plant biology - from experimental design to data analysis. Students will apply their knowledge and critical thinking skills through case studies and analysis of new research findings. This course will encourage students to use their strengths and interests to explore plant pathology and will allow flexibility to explore student questions and curiosities.

Instructor(s): K. Butler Terms Offered: Winter
Prerequisite(s): BIOS 10130 Principles of Biology, or BIOS 10140 Inquiry-based Exploration of Biology, or a score of 4 or 5 on the AP Biology test. This course is not intended for biological sciences majors or students fulfilling requirements for admission into health professions graduate programs.

BIOS 16120. The Biological Nature of Psychological Problems. 100 Units.
This course is based on the strong assumption that psychology is a biological science, albeit with elements of the social sciences. The course uses a combination of lectures and classroom discussion of primary and secondary source readings assigned for each class meeting. It presents a strong biological science perspective on individual differences in emotions, motivations, and cognitions that cause distress or interfere with adaptive life functioning, but does so in a non-stigmatizing manner. The course begins with a description and discussion of the nature of psychological problems. The course will survey what is known about the genetic, environmental, and epigenetic bases of such problems and the methods used to study genetic influences and gene-environment interactions. Next, students will review what is currently known about the neural and other biological mechanisms involved in maladaptive individual difference in emotion, motivation, and cognitive processes, with discussion of the methods of studying such mechanisms in humans and nonhumans. The pros and cons of the medical model of ‘mental illness’ will be discussed as the major contrast with the natural science view advocated by the instructor.

Instructor(s): B. Lahey Terms Offered: Spring
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-MAJOR PRE-MED STUDENTS, except by petition.
Equivalent Course(s): PSYC 28850

Two-Quarter Biology Sequences for Non-Majors
These sequences are an alternative to taking BIOS 10130 Principles of Biology or BIOS 10140 Inquiry-based Exploration of Biology plus a Topics course to fulfill the general education requirement in the Biological Sciences. Students MUST take BOTH courses in a sequence.

Metabolism Sequence
BIOS 10500. Metabolism and Exercise. 100 Units.
Must be taken in sequence with BIOS 10501. This course examines the flow of energy through the human body - from the nutrients we eat to the activities we perform. This course expands on the basic anatomy and physiology of BIOS 10501 to explore such phenomena as metabolism, temperature and fluid balance, exercise performance, and homeostatic control in times of activity.

Instructor(s): B. Fineschi, M. Osadjan Terms Offered: Winter
Prerequisite(s): BIOS 10501. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

Note(s): This course must be taken subsequent to BIOS 10501 Systems of the Human Body. L.
BIOS 10501. Systems of the Human Body. 100 Units.
Must be taken in sequence with BIOS 10500. This course examines the structure and function of the human body, spanning from submicroscopic molecules to the most visible aspects of the human body. The course introduces the anatomy (body structure) and physiology (body function) of our various body systems in their resting and ready states. In the second course of the sequence (BIOS 10500), the body will be re-examined in its active, dynamic state.
Instructor(s): B. Fineschi, M. Osadjan Terms Offered: Autumn
Prerequisite(s): This course MUST be followed by BIOS 10500 to satisfy the general education requirement in biological sciences. Completion of only BIOS 10501 will count as a topics course. NO BIOLOGICAL SCIENCES MAJORS, except by petition.

COMPUTER MODELING SEQUENCE
BIOS 10602. Multiscale Modeling of Biological Systems I. 100 Units.
Modern biology generates massive amounts of data; this course is devoted to biological information and the models and computational techniques used to make sense of it. The first course in the sequence begins with the organization of life at the molecular level, and builds a physical understanding to the structure of macromolecules such as DNA, RNA, and proteins. Students learn about biological databases, algorithms for sequence alignment and phylogenetic tree building. Students will also be introduced to basics of high performance computation and its application to the field of bioinformatics. They will learn how to use our in-house supercomputer to process and analyze next generation gene sequencing data in order to identify disease-relevant variants. Students implement computational algorithms using R and Unix.
Instructor(s): E. Haddadian Terms Offered: Autumn, L.
Prerequisite(s): MATH 13300/15300/16300 or equivalent placement. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition. This course MUST be followed by the second course in the sequence.

BIOS 10603. Multiscale Modeling of Biological Systems II. 100 Units.
Must be taken in sequence with BIOS 10602. Major Advances in understanding how life works at the molecular level have revolutionized biology. The second course in the sequence is dedicated to the study of how large molecules, such as proteins, DNA, carbohydrates, and phospholipids, perform their functions. The course will begin with a solid grounding in molecular chemistry and the forces that govern interactions between atoms and molecules. This is followed by an overview of structure and function of macromolecules, in particular of proteins and enzymes. The students will learn how to visualize macromolecules and measure their basic properties and to model their physical movements by means of molecular dynamic simulations running at university’s super computer facility. The course will then proceed to describe how interactions of these molecules produce functioning organelles and cells, and how molecular mishaps can lead to disease.
Instructor(s): E. Haddadian Terms Offered: Winter, L.
Prerequisite(s): BIOS 10602 or consent of instructor. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

HEALTH PROFESSIONS PREPARATION SEQUENCE FOR NON-MAJORS
BIOS 20170 through BIOS 20175
This integrated sequence explores the molecular, cellular, organismal, and biochemical properties of living systems. It is designed to prepare students who do not intend to major in Biological Sciences or Biological Chemistry for graduate study in the health professions. This five-course sequence begins with BIOS 20170 Microbial and Human Cell Biology in the Winter Quarter and both BIOS 20171 Human Genetics and Developmental Biology and BIOS 20172 Mathematical Modeling for Pre-Med Students I in the Spring Quarter. BIOS 20170 and BIOS 20171 will complete a student’s general education requirement in the biological sciences. BIOS 20172 must be taken concurrently with BIOS 20171. The second year of the sequence continues with BIOS 20173 Perspectives of Human Physiology in the Autumn Quarter and concludes with BIOS 20175 Biochemistry and Metabolism in the Winter Quarter. The Fundamentals Sequence for Biological Sciences majors is also open to non-majors completing their pre-med biology requirements and provides comparable topical coverage. This sequence is open only to students who are not planning to major in Biological Sciences or Biological Chemistry and cannot be applied to either of these majors. We recommend that students start the sequence in their first or second year.

BIOS 20170. Microbial and Human Cell Biology. 100 Units.
This course is the entry point into an integrated biology sequence designed to prepare non-biology majors for application to schools in the health professions. We explore topics in human cell biology within the context of evolutionary biology, chemistry, microbiology, and medicine. We pay special attention to the influence of prokaryotes on the history of life and to the ecological interactions between humans and their microbiota, which have major implications for human health and disease. Students read and discuss papers from the scientific literature, attend discussions and gain experience with microbiological basic microscopy techniques in lab.
Instructor(s): C. Andrews, R. Bednarczyk Terms Offered: Winter, L.
Prerequisite(s): This sequence is open only to students who are not planning to major in Biological Sciences or Biological Chemistry and cannot be applied to either of these majors. It is recommended that students start the sequence in their first or second year.
BIOS 20171. Human Genetics and Developmental Biology. 100 Units.
This course covers the fundamentals of genetics, with an emphasis on human traits and diseases. Topics include Mendelian genetics, simple and complex traits, genetic diseases, the human genome, and testing for human traits and diseases. After establishing a foundation in genetics, we will discuss mechanisms underlying differentiation and development in humans. We will focus on events that lead to gastrulation and the establishment of the body plan (how humans develop from an un-patterned egg into a recognizable human form). Other topics may include limb development and stem cell biology.
Instructor(s): O. Pineda-Catalan, Staff. Terms Offered: Spring, L.
Prerequisite(s): BIOS 20170; must be taken concurrently with BIOS 20172.

FUNDAMENTALS SEQUENCES FOR BIOLOGICAL SCIENCES MAJORS

All first-year students who wish to major in Biological Sciences must take BIOS 20153 Fundamentals of Ecology and Evolutionary Biology in the Winter Quarter and either BIOS 20151 Introduction to Quantitative Modeling in Biology (Basic) (Spring) or BIOS 20152 Introduction to Quantitative Modeling in Biology (Advanced) (Winter) as prerequisites for the Fundamentals Sequence courses, which form the foundation of the Biological Sciences major. BIOS 20153 and BIOS 20151 or BIOS 20152 will satisfy the general education requirement in the biological sciences. Majors will go on to complete one of the Fundamentals Sequences.

BIOS 20151. Introduction to Quantitative Modeling in Biology (Basic) 100 Units.
The goal for this course is to give future biologists the quantitative tools to fully participate in modern biological research. These include descriptive statistics, linear regression, stochastic independence and hypothesis testing, Markov models and stationary probability distributions, solutions of linear differential equations, equilibria and stability analysis of nonlinear differential equations. The ideas are applied to different areas of biology, e.g. molecular evolution, allometry, epidemiology, and biochemistry, and implemented by students in computer assignments using the R computational platform.
Instructor(s): Section 1: D. Kondrashov; Section 2: A. Basu Terms Offered: Spring, L.
Prerequisite(s): Two quarters of calculus of any sequence (MATH 13200 or 15200 or 16200). First-year Biology Major standing only.
Note(s): This course is required to partially fulfill the general education requirement in biology for Biological Sciences majors in all tracks, except for students taking BIOS 20152 and students in the Advanced Biology sequence. This course cannot be used as a Topics course for the general education requirement for non-Biological Sciences majors.

BIOS 20152. Introduction to Quantitative Modeling in Biology (Advanced) 100 Units.
This is a more advanced version of 20151, intended for students with greater mathematical maturity. In addition to the topics covered in the regular version, students will learn about nonlinear least-squares fitting, eigenvalues and eigenvectors, bifurcations and bistability in differential equations. Additional applications will include phylogenetic distance and systems biology.
Instructor(s): D. Kondrashov Terms Offered: Winter, L.
Prerequisite(s): MATH placement of 15200 or higher OR either MATH 15200 or MATH 16200 and second-year standing or higher.
Note(s): This course can replace BIOS 20151 to partially fulfill the general education requirement in biology for Biological Sciences majors in all tracks. This course cannot be used as a Topics course for the general education requirement for non-Biological Sciences majors.

BIOS 20153. Fundamentals of Ecology and Evolutionary Biology. 100 Units.
This course surveys the basic principles of ecology and evolutionary biology to lay the foundation for further study in all fields of biology. Broad ecological concepts, such as population growth, disease dynamics, and species interactions, will be explored through a combination of published data, simulations, and mathematical models. The emphasis is placed on “ecological thinking”. Essential topics in the modern study of evolutionary biology will be covered with a focus on both theory and empirical examples. Examples of topics include history of evolutionary thought, evidence for evolution, mechanisms of microevolution, phylogenetics, molecular evolution, and speciation.
Instructor(s): M. Kronforst, C. Brook, C. Andrews, A. Hunter. Terms Offered: Winter, L.
Note(s): This course is required to partially fulfill the general education requirement in biology for Biological Sciences majors in all tracks, except for students taking the Advanced Biology sequence.

SPECIFIC GENERAL EDUCATION REQUIREMENT FOR CERTAIN MAJORS

Students should note that several majors have specified requirements for how the biological sciences portion of the general education requirements must be satisfied.

These include Biological Chemistry, Neuroscience, Environmental Science, Geophysical Sciences, and Molecular Engineering.