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 Metabolism and Nutrition 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.

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. Cancer Biology. This course covers most basic concepts of biology such as the characteristics of life, structure, function and division of the cell, macromolecules, metabolism, genetics and principles of evolution. It will also explore how DNA is replicated and transcribed and how proteins are made. As genes control many biological processes, gene regulation will be discussed. An integral part of this course will be the discussion of how anomalies of most of the introduced concepts may lead to cancer. Selected lectures will be delivered in a flipped format, and team-based and other active learning pedagogies will be adopted in this course. Lab activities will be integrated in the course materials. Reading of assigned scientific topics, writing exercises, team-innovative projects and presentations will be used for assessment. A. Fawzy. Autumn, Winter, L.

D. 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.

E. Developmental Biology and Aging. This course will investigate the mechanisms of how an animal is formed and the age-related changes that occur after development. We will make connections between developmental biology and aging with principles of biology such as genetics, cell biology, molecular biology, and evolution. Students will explore the topics through lectures, reading of popular and scientific literature, group work, discussion, and hands-on laboratories. P. Smith. Autumn, 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 10130.

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: Exploring Biodiversity and dynamic ecosystem of the human microbiome. Human beings are an ecosystem, with multiple types of microbes living in various niches within the human body. How these “multitudes” in our body become established, interact with each other and react to the chemicals in our foods (nutrients and specific chemicals, antibiotics and more) is a Grand Challenge question. Through the exploration of beneficial (probiotic) microbes and potential food-borne pathogens, and the susceptibility of these organisms to antibiotics and spices in our diets, students will be introduced to various fundamental biological principles. Students will study life processes ranging from molecular to cellular to organismal levels and then extend to populations and ecosystems. Working in groups, students will identify a microbiome and antimicrobial specific question, propose a testable hypothesis and develop an inquiry-based research project. They will also learn to navigate the professional scientific literature and critically evaluate published scientific information. Supplemented by short lectures and discussions of the scientific literature, they will get familiar with the logic of scientific reasoning and methods for collecting, analyzing and communicating scientific data. 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
The 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 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.

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 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: 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.
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: Autumn
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; No Biological Sciences majors except by petition to the BSCD Senior Advisers.

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. 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 Winter
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): ENST 13132

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

BIOS 13141. The Mathematics of Evolution. 100 Units.
In this course, students will learn fundamental concepts and models of population dynamics, selection and evolution. The course will emphasize the importance of population thinking, information, chance, competition and selection in finite populations in determining dynamical outcomes. We will emphasize how genetic information can be modeled and transmitted under variation and selection across generations, providing a modern framework to understand mathematical theories of evolution by natural selection. This then leads to the central theme of the course, creating a general view of evolution as learning in populations, which establishes connections between ecology and evolution and computer science, economics and complex systems.
Instructor(s): L. Bettencourt, M. Steinruecken Terms Offered: Winter
Prerequisite(s): Prerequisite(s): BIOS 10130, STAT 22000, and MATH 13300 or higher. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

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.
Instructor(s): P. Sereno; L. Rogers; S. London Terms Offered: May be offered 2023-2024
Prerequisite(s): Third or fourth-year standing. This course does not meet the requirements of the Biological Sciences major.
Equivalent Course(s): ASTR 18700, PSYC 28810, BPRO 28800

**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 required.

Instructor(s): Russell Tuttle Terms Offered: Spring, Spring 2023
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition. Preference to 3rd and 4th year Anthropology Majors.
Equivalent Course(s): HIPS 21428, ANTH 21428, ANTH 38600, EVOL 38600

**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.

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

**BIOS 14114. Drugs Galore: What They Are and What They Do to You. 100 Units.**

The course will cover several drugs used and abused (such as alcohol, ritalin, adderall, cannabinoids), their targets and pharmacological actions.

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

**BIOS 14116. Introduction to Social Neuroscience. 100 Units.**

This course on social neuroscience addresses a timely topic in the fields of medicine, psychology, and the neurosciences. Specifically, a key challenge in the study of the brain and its effects on health and behavior resides not only in determining how one's mental processes map onto their own patterns of brain activity but also how this activity is modulated by shared representations with other individuals through various neural, hormonal, cellular, and genetic mechanisms. These are questions that fall within the field of social neuroscience - the study of the neural, hormonal, cellular, and genetic mechanisms underlying the super-organismal structures. When social neuroscience was first proposed a quarter century ago, attention was given to why the notion of "social neuroscience" was not an oxymoron and to articulate a set of principles (multilevel analysis) that justified attention to super-organismal structures (e.g., a pair bond, marriage, salutary relationship) in the analysis of the function of the nervous system and brain. This was prior to the recognition of the importance of epigenetics and the sophisticated means of probing the neural aspects of shared representations, embodied cognition, that exist today. Indeed, genes were still thought to be strong if not invariant determinants of human illness, phenotypes and behavior. So where does social neuroscience now fit within medicine and the science of brain, mind, and behavior? That is the focus of the course.

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

**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 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 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 what we eat to what we can do. Basic physiology, metabolism, and exercise concepts are covered from cells to systems. Students should be prepared to alter their diet and/or physical activity. This course is intended to be followed by BIOS 10501 (Metabolism and Nutrition). Prerequisite(s): This course MUST be followed by the second course in the sequence. NO BIOLOGICAL SCIENCES MAJORS, except by petition.
Instructor(s): J. Kennedy Terms Offered: Autumn
Prerequisite(s): This course MUST be followed by the second course in the sequence. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

**BIOS 10501. Metabolism and Nutrition. 100 Units.**
Must be taken in sequence with BIOS 10500. Taking a scientific approach to nutrition, this course covers nutritional requirements and why they are required for human health by exploring their function at the cellular and molecular level. Basic physiology concepts related to nutritional health are covered, including digestive physiology and some aspects of endocrinology. As a continuation of the exercise concepts covered in BIOS 10501, the relationship between exercise and nutrition is considered. Students complete a dietary analysis of their food intake to critique their individual nutritional health.
Instructor(s): P. Strieleman Terms Offered: Winter
Prerequisite(s): BIOS 10500. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

**Note(s):** Credit may not be earned for both BIOS 10501 and BIOS 12114.

**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 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 toward 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, biochemistry, and microbiology. 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. Zaragoza, E. Kovar 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, R. Zaragoza 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, X. Liu 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 on "ecological thinking" rather than specific notions. 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): T. Price, M. Kronforst, 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.