Biological Sciences

The Biological Sciences Core Requirement

All students are required to complete at least two quarters of Biological Sciences course work to satisfy the general education (i.e., Core) requirement in the Biological Sciences. The goal of the first quarter course is to provide students with a broad foundational understanding of biology and an understanding of scientific reasoning and experimental approaches to hypothesis testing. The second course provides an opportunity to focus on a specific area of interest within Biology. The requirement should be completed by the end of the second year.

Most students complete the General Education requirement in the Biological Sciences in one of five ways:

1. A two-quarter General Education Sequence for non–Biological Sciences majors:

- BIOS 10130 Principles of Biology (which may be granted for some students via AP, IB, or A-Level exam credit) OR BIOS 10140 Inquiry-based Exploration of Biology
- AND any Topics course (course numbers BIOS 11125-BIOS 16120 and BIOS 27710-27779)

2. A two-quarter integrated sequence for non-Biological Sciences majors:

- BIOS 10501 Systems of the Human Body and BIOS 10500 Metabolism and Exercise
- OR BIOS 10602 Multiscale Modeling of Biological Systems I and BIOS 10603 Multiscale Modeling of Biological Systems II)

3. The first two courses in the Health Professions Preparation Sequence for Non-Majors. This sequence is designed 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. For students who take the whole sequence (BIOS 20170 Microbial and Human Cell Biology through BIOS 20175 Biochemistry and Metabolism), BIOS 20170 and BIOS 20171 satisfy the general education requirement in the biological sciences.

4. 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. Note: Non-majors may not use BIOS 20151 as a topics course.

5. Completion of three quarters of the Advanced Biology Fundamentals Sequence. Students granted credit for BIOS 10130 due to their AP, IB, or A-Level exam scores have the option to enroll in the Advanced Biology Fundamentals Sequence. Students who complete the first three quarters of an Advanced Biology Fundamentals Sequence (BIOS 20234 Molecular Biology of the Cell through BIOS 20236 Biological Dynamics) will be awarded an additional 100 units 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 (http://collegecatalog.uchicago.edu/thecollege/biologicalsciences/) Program of Study page in this catalog. This option is especially appropriate for students who plan to major in Biological Sciences and prepare for a career in research, but it is open to all qualified students including those planning a career in the health professions.

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 (http://collegecatalog.uchicago.edu/thecollege/biologicalchemistry/), Biological Sciences (http://collegecatalog.uchicago.edu/thecollege/biologicalsciences/), Climate and Sustainable Growth, (http://collegecatalog.uchicago.edu/thecollege/climate/) Neuroscience (http://collegecatalog.uchicago.edu/thecollege/neuroscience/), Environmental Science (http://collegecatalog.uchicago.edu/thecollege/environmentalscience/), Geophysical Sciences (http://collegecatalog.uchicago.edu/thecollege/geophysicalsciences/), and Molecular Engineering (http://collegecatalog.uchicago.edu/thecollege/molecularengineering/).

AP, IB, or A-Level Exam Credit

Upon enrollment in the College, students with select scores from the AP, IB, or A-Level exam (http://collegecatalog.uchicago.edu/thecollege/apibalevelexams/)s will be awarded credit for BIOS 10130 Principles of Biology. 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, this credit will apply toward the general education sequence for non-Biological Science majors articulated above. These students should complete the general education requirement in the Biological Sciences with either one or two Topics courses for non-majors, depending on how the requirements in the mathematical and physical sciences are met; students should contact their academic adviser for details.

Biological Sciences Core 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
Note(s): Credit cannot be earned for both BIOS 10130 and BIOS 10140.

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 foundational 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 is highlighted in many ways. Hands-on laboratories, readings, and discussion sessions complement lectures. *B. Fineschi. Autumn, Winter, Spring. L.*

B. 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.*

C. Genetic Basis of Disease. This course is a survey course that will explore the foundational concepts of biology including biomolecules, cell structure and function, patterns of inheritance and gene expression, animal physiology, and mechanisms of microevolution. These foundational concepts will be discussed in the context of genetic disorders that can have profound effects on physiological systems. The course will teach students how organisms form gametes and reproduce, pass on their traits, and express the genes they inherit. We will also explore how mutations arise that can cause single gene disorders and discuss their effects on specific physiological systems. Students will consider how populations evolve and understand why harmful alleles are able to persist in our gene pools, despite the detrimental effect they can have on our physiology. Hands on laboratories to reinforce content learned in class, readings, and in class active learning will complement lecture material. *J. Gifford. L.*

BIOS 10140. Inquiry-based Exploration of Biology. 100 Units.
This inquiry-based approach permits students to learn fundamental biological principles while carrying out scientific experiments and expanding our knowledge of living systems. Each course will focus on a different Grand Challenge question in biology. In this context, students will conduct their own research projects to experience how biologists frame questions and test hypotheses. 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. 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): Credit cannot be earned for both BIOS 10130 and BIOS 10140.

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. How do genetics and environment influence the working of the brain? Embedded within this Grand Challenge 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 this Grand Challenge 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 are central to our understanding of how urbanization impacts plant pollination, water filtration, waste decomposition, and other critical ecological processes. 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. *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. Winter. L.*

E. *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. Bednarczyk. Autumn. Winter. L.*

F. *Sex Differences and Dimorphism.* How do chromosomal and/or hormonal differences between the sexes influence behavior? Can life history, social interactions, or environmental exposures modulate behavioral differences between males and females of a species? Sex is a fundamental variable that is often disregarded in basic and biomedical research. Across many disciplines, including neuroscience and pharmacology, we risk drawing invalid conclusions when we extrapolate data from one sex to another. We will use *Drosophila* as a model to explore how chromosomal sex may influence both reproductive and non-reproductive behaviors, and discuss the evolutionary foundations of such differences. Students will develop their own research project and carry out novel experiments designed to test their hypotheses. Throughout this process, students will learn about fundamental principles in biology and the logic of scientific reasoning and experimental design, and will develop strategies to support the effective collection, analysis, and communication of scientific information. Student engagement in inquiry will be complemented by lectures and critical examination and discussion of the scientific literature. C. Martineau. *Winter. L.*

G. *Genetics of Plants.* How can we feed the world as the climate changes and plants are exposed to more stressful growing conditions? A possible approach is to improve the genetics of our crop plants, but first we need to identify the genes that could help! This course will use the model plant *Arabidopsis thaliana* to understand the genetics behind abiotic stress responses in plants. By exploring the natural variation in *Arabidopsis* populations,

we can try to identify the genes that allow some plants to survive in stressful conditions. Working together, the class will conduct a large-scale genome analysis after which students will work in groups to conduct their own genetic study, report their findings, and propose new experiments. Throughout the course, students will learn about fundamental principles in biology and experimental design while gaining experience with genetic analysis, plant biology, and scientific communication *K. Butler. Autumn, Spring. L.*

H. *Evolution and Ecology.* #As the Earth's climate changes, how will it affect organisms?To answer this question, we can manipulate and analyze large data sets available online such as species occurrence over time, phenological records, population sizes, climate past and projected, and mortality and growth rates of different species. We will dive in to fundamental principles of biology to see how the physiology, ecology, and genetic make-up of populations are likely to be affected by changing climate, and how organism responses to change will feed back and affect the climate. We will read both popular science and primary sources to understand how scientists approach these questions. While developing spreadsheet and data analysis skills, we can investigate the responses of organisms to changing climate, how species interact with each other and the abiotic environment, and what the limits to these responses will be. Students will develop a research question and find or gather data from online sources to test hypotheses relevant to their question, then present their results in a poster session.*A. Hunter. Autumn, 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. 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): 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.

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, A. Dahl Terms Offered: Autumn
Prerequisite(s): BIOS 10130 or BIOS 10140; NO BIOLOGICAL SCIENCES MAJORS OR 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 students with an appreciation of important biotechnology breakthroughs and the associated bioethics issues.
Instructor(s): N. Bhasin Terms Offered: Autumn
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

BIOS 11142. Forensic Biology: "Who done it?" - DNA tells the story. 100 Units.
This course is designed to introduce the field of forensic biology to those with an introductory biology background. Starting with a brief overview of relevant basic concepts of molecular biology, genetics, and inheritance patterns, the course will explore the crucial role played by individuals' unique DNA in precisely solving mysteries of missing people and crimes. This course will combine theoretical knowledge with hands-on experimentation to provide a comprehensive understanding of forensic biology with a focus on DNA analysis. In this course, we will also cover adjacent topics such as identity-by-descent and the use of non-human DNA in Forensics, and also expand on the legal and ethical implications surrounding this form of investigation. Upon completion, students will gain a comprehensive understanding of DNA analysis in forensic investigations, including the limitations in current practice. They will be empowered to contribute to the enhancement of criminal justice and public safety policies and guidelines.
Instructor(s): N. Bhasin Terms Offered: Summer. September Term.

Prerequisite(s): BIOS 10130 or 10140. NO BIOLOGICAL SCIENCES MAJORS AND NO NON-BIOLOGY PRE-MEDS, except by petition.

BIOS 11143. Small Molecule, Big Targets: Fundamentals of Structure-based Drug Design. 100 Units.
This course introduces undergraduate students to the chemical basis of drugs and principles of structure- based drug design, with a focus on how drugs interact with biological targets at the molecular level. Students will engage with primary literature case studies and immersive technologies involving virtual and mixed reality (VR/MR) to explore the process of rational drug design. The course emphasizes how protein structure informs drug discovery and the strategies used to optimize ligand binding and therapeutic efficacy. Students will gain hands-on experience to visualize how small molecules bind to target proteins, evaluate their potential as drug candidates, and experiment with ways to improve them. Through collaborative learning and interactive tools, students will connect theory to practice and develop a deeper understanding of the molecular logic driving modern drug discovery.
Instructor(s): W.Y. Low Terms Offered: Autumn
Prerequisite(s): BIOS 10130 Principles of Biology, or BIOS 10140 Inquiry-based Exploration of Biology and an introductory chemistry course.

BIOS 12115. Stress Response of Cardiac and Neuronal Systems. 100 Units.
The course will discuss basic concepts involved in the functioning of cardiac and neuronal systems, followed by various-types of patho-physiologic stresses experienced by the heart and brain, and how these organ systems adapt to stress conditions by turning on "emergency response" mechanisms at the molecular, cellular, tissue and organ levels. We will also discuss current strategies and drugs designed to treat mal-adaptive changes taking place in these organ systems under stress conditions. Instructors, who are actively engaged in basic and translational research aimed to understand molecular basis of cardiac and neuronal diseases, will take this course beyond the knowledge of standard textbook content.
Instructor(s): M. Gupta, W. Sharp. Terms Offered: Spring
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 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 & 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.
Equivalent Course(s): CEGU 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 interests to explore the biology and significance of plants and will allow flexibility to explore student questions and curiosities.
Instructor(s): K. Butler Terms Offered: TBD
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

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 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 in 2027-2028
Prerequisite(s): PQ: Third or fourth-year standing. This course does not meet the requirements of the Biological Sciences major. Prerequisite(s) for BIOS 13142 only: BIOS 10130 or BIOS 10140. For BIOS 13142: NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.
Equivalent Course(s): BPRO 28800, PSYC 28810

BIOS 14112. Workings of the Human Brain: From Brain to Behavior. 100 Units.
How do humans see, smell, hear, feel, think, and learn? This course examines how the brain generates behavior. Topics covered 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 conditions. Each week, we will begin with a review of the microscopic workings of the cell and basic neuroanatomy and functional physiology and continue to a more macroscopic study of the senses, behavior, higher order mental processes, and psychological disorders. The goal of the course is to provide students with a basic understanding of how fundamental brain processes contribute to cognitive states and basic human behavior, as well as encourage further study in the "brain and behavioral sciences."
Instructor(s): M. McNulty, M. Tan Terms Offered: Autumn Summer
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS, NEUROSCIENCE MAJORS, OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

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

BIOS 14118. Mechanisms of Memory: How the Brain Stores Information. 100 Units.
Our memories greatly shape who we are. Whether it is our memories of past experiences, facts and information, or how to play an instrument, our memories influence how we interact and think about the world around us. In this course, we will investigate the processes through which the brain supports our ability to learn and remember. We will examine the brain regions involved in the different types of memory and study the dynamic cellular mechanisms that take place during learning. The goal of this class is to provide students with a basic understanding of how fundamental neurobiological mechanisms contribute to the complex behaviors of learning and memory, as well as to foster appreciation and engagement with neuroscience and other biological sciences.
Instructor(s): C. Heer Terms Offered: Spring
Prerequisite(s): BIOS 10130 or BIOS 10140; NO BIOLOGICAL SCIENCES MAJORS, NEUROSCIENCE MAJORS, AND NO NON-BIOLOGY PRE-MEDS, 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 15126. Biology and Epidemiology of Cancer. 100 Units.
This course focuses on an introduction to cancer providing a biological perspective on how cancer arises and further progresses as a disease. The course will additionally focus on the ways in which genetics and environmental factors contribute to specific types of cancer. A brief analysis of the epidemiology of some cancers will be discussed in addition to providing an overview of the traditional and emerging cancer therapeutics and 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: Autumn
Prerequisite(s): BIOS 10130 or BIOS 10140. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, except by petition.

Topics Courses offered at Marine Biological Laboratory

These courses are offered at MBL during the September Term. Students choose one course.

BIOS 27720. Microbiomes Across Environments. 100 Units.
This course provides a comprehensive introduction to the theory and techniques of microbiome science, an emerging field that bridges disciplines, merging microbiology with genomics, ecology, population and evolutionary biology, phylogenetics, ecosystem science, and biogeochemistry, and has broad applications in medicine, agriculture, and ecosystem health. Through a combination of faculty and guest lectures and student-led discussion of primary literature we will explore the vast biochemical and metabolic diversity of the microbial world and its relationships with multicellular life. The major component of the course is an independent research project investigating the microbiomes of marine organisms collected by the students or resident in the MBL's Marine Resources Center, or of a salt marsh ecosystem in Woods Hole. Students develop their own hypotheses and sampling strategies, carry our sampling, extract DNA, and perform PCR for sequencing. The last third of the course is devoted to data analysis, where students learn to use the Unix-based bioinformatic tools necessary to

find patterns in the hundreds of thousands of DNA sequences their project produced, a skill broadly applicable to any discipline in modern biology.
Instructor(s): D. Mark-Welch and B. Paul Terms Offered: Spring. L. Offered as part of the Spring Semester of Biological Discovery at MBL

BIOS 27723-27726-27727-27728. SEPTEMBER COURSES AT MARINE BIOLOGICAL LABORATORY, WOODS HOLE.
The September courses combine lecture with hands-on learning and development of independent research ideas and projects. All are taught by University of Chicago or MBL faculty, and take advantage of the unique research strengths and the natural environmental resources found at MBL. These are intensive, three-week-long courses that meet for up to eight hours per day for 5–6 days per week, combining morning lectures with afternoon labs and fieldwork. Each student can only enroll in one course at a time. The September courses at MBL have no prerequisites, and can count either to fulfill the general education requirement in Biology OR as an upper-level elective. More information, including application details and program fees, can be found at https://college.uchicago.edu/academics/mbl-september-courses. The MBL September courses end before classes commence in Chicago.

BIOS 27723. Biodiversity and Genomics: Exploring the Marine Animal Diversity of Woods Hole Using Molecular Tools. 100 Units.
In this course, student will have the opportunity to explore the large diversity of marine animal species in Woods Hole, Massachusetts and its surroundings. We will combine fieldwork with genomic and bioinformatic approaches to study different aspects of the evolution, ecology, taxonomy, physiology, and biogeography of marine animals in this unique location. Student will integrate knowledge and analytical tools from different biological disciplines to develop short research projects. During the three weeks of the course, student will have access to the Marine Biological Laboratory's collection of living marine animals, participate in ongoing research projects at MBL, and contribute data that will advance our understanding of marine biodiversity.
Instructor(s): O. Pineda-Catalan Terms Offered: Summer. L. September term.
Note(s): This course will be given at Marine Biological Laboratories, Woods Hole, Massachusetts. E.

BIOS 27726. Marine Ecosystems: From Microbiomes, to Conservation, Climate & Beyond. 100 Units.
This course is designed for rising 2nd years with interests in microbiology, the environment, and society. More specifically, the course is designed for students considering a science major, as well as non-majors, who are looking for broad exposure to geosciences, environmental and climate science, microbiology, molecular biology, and the intersection between society and science. Students will study coastal marine habitats, connectivity to ocean and climate, dynamics of microbial community structure, and marine conservation alongside gaining experience on laboratory microbiome science and environmental field work. Students will gain firsthand experience with the types of microbes that that influence climate and that impact health through laboratory experiments on culturing and analyzing microbes in 'pristine' and highly impacted coastal ecosystems. Methods to be learned include plating, epifluorescence microscopy, flow cytometry, DNA extraction, and sequencing. Lectures will cover marine microbiology, CO2 sequestration (natural and engineered), geochemistry, coastal and open ocean habitat structure, and links to climate and the climate crisis. We will also address equity issues in marine conservation and the climate crisis. While all field work will be coastal, students will also learn about the open ocean due to the key linkages of water masses as well as climate feedback.
Instructor(s): A. Worden Terms Offered: Summer. L. September term. This course will be given at Marine Biological Laboratories, Woods Hole, Massachusetts. E.
Equivalent Course(s): ENSC 24600

BIOS 27727. Light and Color in the Ocean. 100 Units.
Spectacular optical adaptations shape marine life, from sunlit shallows to the deep sea. We will explore how ocean creatures manipulate light-becoming transparent, ultra-black, iridescent, vividly colored, or bioluminescent-through the lens of physics, photosynthesis, and visual systems. With morning lectures, afternoon hands-on work, local outings, and a final research project, students will learn the physics and biology of light in the ocean. We encourage students to develop publishable original research projects using the fantastic resources of the MBL.
Instructor(s): D. McCoy Terms Offered: Summer. September Term at MBL. L.
Prerequisite(s): This course will be given at Marine Biological Laboratories, Woods Hole, Massachusetts. E.

BIOS 27728. The Meaning of Life: Experimenting with the History of Biology in Woods Hole. 100 Units.
This course, taught on-site at the Marine Biological Laboratory (MBL) in Woods Hole Massachusetts, examines early twentieth century biology through hands-on recreations of classic experiments. Course undertakings include working with organisms like sea urchins, starfish, hydras, slipper snails, and plankton; fieldwork in local beaches, ponds, and marshes; laboratory experimentation using early twentieth century equipment; and close readings of historical sources in early twentieth-century experimental biology. By the end of this course, students will have gained experiences collecting, identifying, caring for, and working with classic invertebrate model organisms; they will be able to identify and explain key concepts and techniques in biology between 1900 and today; and they will be able to parse historical sources and recreate the knowledge-making strategies that shaped early twentieth century biology.

Instructor(s): M. Rossi Terms Offered: Summer. September Term at MBL
Prerequisite(s): This course can be counted as a biology topics course or as an upper-level elective for biology majors.
Equivalent Course(s): CEGU 27728

BIOS 27725. Biogeography and Distribution of Species. 100 Units.
Students will explore various aspects of the biota of the region surrounding the Marine Biology Laboratory, Woods Hole, MA. The focus of the course will be to examine various patterns in the distribution and abundance of the flora/fauna in the islands and associated mainland habitats over the course of 3 weeks through a combination of in class lectures and laboratory sessions, combined with field studies. Penikese Island will receive special focus for extensive inventory of the biota, to update previous contributions to the flora of the island and begin an inventory of mammals, birds, and invertebrates. Similar surveys will be made of nearby mainland habitats for biogeographic comparisons between island and mainland patterns of abundance.
Instructor(s): E. Larsen Terms Offered: Summer. L. September term.
Note(s): This course will be given at Marine Biological Laboratories, Woods Hole, Massachusetts. E.

Marine Biological Laboratory Semester in Environmental Science and Semester in Biological Discovery Courses

These two programs are offered at MBL and are open to students of all majors. They are biology intensive programs. One biology course from MBL programs may count as a topics course. For more information about these programs please visit https://college.uchicago.edu/academics/college-marine-biological-laboratory (https://college.uchicago.edu/academics/college-marine-biological-laboratory/).

BIOS 27710. Ecology - Marine Biological Laboratory. 100 Units.
This course examines the structure and functioning of terrestrial and aquatic ecosystems including the application of basic principles of community and ecosystem ecology. The course also examines contemporary environmental problems such as the impacts of global and local environmental change on community composition and food webs within forest, grassland, marsh and nearshore coastal ecosystems on Cape Cod. This course examines the structure and functioning of terrestrial and aquatic ecosystems including the application of basic principles of community and ecosystem ecology. The course also examines contemporary environmental problems such as the impacts of global and local environmental change on community composition and food webs within forest, grassland, marsh and nearshore coastal ecosystems on Cape Cod.
Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn. L.
Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27711 and BIOS 27712 along with one of BIOS 27713, BIOS 27714 or BIOS 27715.
Note(s): E.
Equivalent Course(s): ENSC 24100

BIOS 27711. Biogeochemical Analysis in Terrestrial and Aquatic Ecosystems # Marine Biological Laboratory. 100 Units.
This course examines the interface of biological processes with chemical processes in ecological systems. Course content emphasizes aquatic chemistry and the role of microbes in the cycling of nitrogen, carbon, and other elements. Effects of global changes on chemical cycling are emphasized.
Instructor(s): Marine Biological Laboratory Staff. Terms Offered: Autumn. L.
Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710 and BIOS 27712 along with one of BIOS 27713, BIOS 27714 or BIOS 27715.
Note(s): E.
Equivalent Course(s): ENSC 23820

BIOS 27712. Independent Undergraduate Research in Environmental Sciences Marine Biological Laboratory. 100 Units.
This course is the culmination of the Semester in Environmental Science at the Marine Biological Laboratory. An independent research project, on a topic in aquatic or terrestrial ecosystem ecology, is required. Students will participate in a seminar for scientific communication as well as submit a final paper on their project.
Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn. L.
Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710 and BIOS 27711 along with one of BIOS 27713 or BIOS 27714.
Note(s): E.
Equivalent Course(s): ENSC 29800

BIOS 27713. Quantitative Environmental Analyses # Marine Biological Laboratory. 100 Units.
This course emphasizes the application of quantitative methods to answering ecological questions. Students apply mathematical modeling approaches to simulating biological and chemical phenomena in terrestrial and marine ecosystems.
Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn. L.

Prerequisite(s): Consent Only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710, BIOS 27711 and BIOS 27712.
Note(s): E.
Equivalent Course(s): ENSC 28100

BIOS 27714. Methods in Microbial Ecology - Marine Biological Laboratory. 100 Units.
This course explores the biology of microbes found in the environment, including relationships with the physical, chemical, and biotic elements of their environment. Emphasis is placed on understanding the science underlying the various methodologies used in the study of these organisms and systems. In the laboratory, students will work with the latest techniques to measure microbial biomass, activity, extracellular enzymes, and biogeochemical processes. Students are also introduced to molecular methods for assessing microbial genomic diversity.
Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn. L.
Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710, BIOS 27711 and BIOS 27712.
Note(s): E.
Equivalent Course(s): ENSC 24200

BIOS 27715. Roles of Animals in Ecosystems # Marine Biological Laboratory. 100 Units.
This course addresses the question, How do animals, including man, affect the structure and function of ecosystems. The course takes an interdisciplinary approach focused on the interactions of animal diversity, migration patterns, population dynamics, and behavior with biogeochemical cycles, productivity, and transport of materials across ecosystems. This course is an elective option within the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA.
Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn
Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710, BIOS 27711, and BIOS 27712.
Note(s): E.
Equivalent Course(s): ENSC 24300

BIOS 27716. Methods and Concepts in Oceanography- at Marine Biological Laboratory. 100 Units.
This immersive course provides students with a thorough introduction to the core methodologies and concepts in oceanographic research. Over a 10-week period, with 3 hours of class each week, students will explore the dynamic systems that shape our oceans and the cutting-edge techniques used to study them. The course combines engaging lectures, hands-on laboratory work, and field work aboard a coastal research vessel to offer a comprehensive introduction to biological oceanography, physical oceanography, biogeochemistry, marine ecology, and the ever-changing nature of our oceans. Students will gain practical experience in key laboratory, field, and ship-board oceanographic techniques, including microscopy, molecular methods like PCR and sequencing, ocean sampling methods such as water column profiling using CTD casts and Niskin bottle grabs, and sediment grabs. Additionally, they will delve into the physical processes that drive ocean circulation, major oceanographic features, the role of primary and secondary production and the microbial loop in marine ecosystems, and the impact of climate change and human activities on ocean health. Throughout the course, students will actively participate in discussions, lab work, and field activities. They will be evaluated based on their engagement, performance in practical sessions, quizzes, and a final project report that synthesizes their learning and research findings.
Instructor(s): Marine Biological Laboratory Staff Terms Offered: Autumn. Offered as part of the Semester in Environmental Science (SES) at MBL in Woods Hole, MA. E.
Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA; concurrent registration in BIOS 27710, BIOS 27711 and BIOS 27712.
Equivalent Course(s): ENSC 25100

BIOS 27717. Marine Resource Use and Conservation- at Marine Biological Laboratory. 100 Units.
Students will learn about coastal and marine resource use and examine threats to ecosystem biodiversity and conservation exploring examples in the Cape Cod region and discussing global case studies. The course will review various methods and uses of aquaculture and mariculture for promoting the blue economy, their potential consequences, but also potential to mitigate climate change and nutrient pollution. We will also review the role of restoration in promoting ecosystem recovery and conservation. Field trips will include visits to local shellfish and finfish hatcheries, ongoing restoration projects, and conservation organizations. The course is organized into focused two- to four-day modules that include lectures, discussions of papers, field trips, and field and lab activities.
Instructor(s): MBL SES Staff Terms Offered: Autumn. Offered as part of the Semester in Environmental Science (SES) at MBL in Woods Hole, MA
Prerequisite(s): Consent only. Admission by application to the Semester in Environmental Science program at the Marine Biological Laboratory in Woods Hole, MA

Equivalent Course(s): ENSC 24450

BIOS 27724. Introduction to Imaging for Biological Research. 100 Units.
Many breakthroughs in science have been made possible by revolutionary advances in our ability to visualize biological processes, and recent progress in microscopy has led to important breakthroughs in understanding life at the molecular, cellular, and organismal level. In this course, we will introduce the students to basic techniques in microscopy, starting with an opportunity for students to build their own simple microscopes, and then proceeding all the way to using state-of-the-art confocal, light sheet, and electron microscopes. Students will explore the challenges of sample preparation, of imaging processes in living cells, and in the computational analysis of imaging data. Throughout the course, students will be able to design their own experiments, and undertake a student-designed research project.
Instructor(s): Wolff, C., Kerr, L. Terms Offered: Spring
Prerequisite(s): Second-year standing or greater (or by consent) and acceptance into the Spring Quarter Program at MBL.
Equivalent Course(s): NSCI 21515

BIOS 27750. Stem Cells and Regeneration: from aquatic research organisms to mammals. 100 Units.
This course will focus on contemporary stem cell biology and regeneration with emphasis on molecular mechanisms and applications. The course will cover the history of stem cell discoveries through the latest advances, including genome-wide profiling, targeted gene editing, and other techniques used in stem cell and regeneration research. A portion of the course will consist of modules where specific stem cell types will be discussed together with relevant diseases they could impact (i.e. stem cells and neurodegeneration). A focus of the course will be around how discoveries in aquatic research organisms have driven the progress in regeneration biology. In this classroom and lab based course, students will have the opportunity to work on an independent research project under the supervision of a Resident Faculty at MBL. The lab portion of the course will introduce and provide hands-on experience on experimental approaches and techniques used in cell biology, development, and regeneration research. There will be a focus on microscopy (brightfield, fluorescence, high-resolution microscopy) and use of open source software to analyze images. There will be an introduction into the use of stains, antibodies, and genetically-encoded fluorescent markers to analyze cellular structures in aquatic organisms that include axolotls, Nematostella, worms, cephalopods and zebrafish. In addition, this course will provide hands-on experience through labs.
Instructor(s): K. Echeverri Terms Offered: Spring
Prerequisite(s): Second-year standing or greater (or by consent) and acceptance into the Spring Quarter Program at MBL.

BIOS 27752. Dynamic Camouflage: Behavior, Visual Perception and Neural Skin Patterning in Cephalopods. 100 Units.
This course takes an integrative approach to understanding a neurally controlled system of dynamic defense against visual predators. Camouflage is a widespread form of defense throughout the animal kingdom in every known habitat - land or sea. In the oceans, cephalopods (cuttlefish, octopus, squid) have evolved a sophisticated sensorimotor system called Rapid Adaptive Coloration, which can instantaneously change their total body appearance within a fraction of a second to range from highly camouflaged to startlingly conspicuous for a wide range of behaviors. The forms and functions of this dynamic system will be teased apart in integrative fashion in a top-down approach from ecology to organismal biology to organs, tissues and cells. The course touches on neural anatomy, sensation, visual perception (including psychophysics) and animal behavior. There are also applied biology aspects of this system that will be presented as well.
Instructor(s): R. Hanlon Terms Offered: Spring
Prerequisite(s): Second-year standing or greater (or by consent) and acceptance into the Spring Quarter Program at MBL.
Note(s): E.
Equivalent Course(s): NSCI 21530

BIOS 27753. Fundamentals of Synapses. 100 Units.
In this course, students will learn about the fundamentals of synapses, from molecular analysis to structure and function. Marine and aquatic models have historically provided a unique opportunity to investigate synaptic function due to the large size of their neurons, including the synaptic connections. Today, these synapse models are used to study basic principles of neuron-to-neuron communication (synaptic transmission), as well as disease mechanisms. In addition to lectures and discussions of key literature, this course will feature hands-on laboratory-based exercises in molecular genetics, imaging and physiology of synapses, as well as independent "discovery" projects to explore new topics in synapse biology.
Instructor(s): J. Morgan, J. Rosenthal Terms Offered: Spring
Prerequisite(s): Second-year standing or greater (or by consent) and acceptance into the Spring Quarter Program at MBL.
Equivalent Course(s): NSCI 21510

BIOS 27760. An Introduction to Parasitology. 100 Units.
This course introduces the diversity of parasitic organisms, both protozoan and metazoan, and explores the life cycles, morphology, genomics, pathology, immunology, epidemiology, and treatment and control of major parasite groups. The focus will be on aquatic species, including those that cause disease in humans and livestock.

The course will involve lectures, a journal club and lab work including carrying out a research project. The lab work and research project will include working on parasitic flatworms; in particular investigating the molecular and cellular biology of a tropical species, Schistosoma mansoni, that is medically important. Here, in this research-led institute, you will contribute novel data and information to ongoing research at MBL that will advance our understanding of parasites. The lab portion will introduce the morphological and molecular techniques that form part of the toolkit used by parasitologists to understand the biology of these organisms, an essential step in the search and development of novel control strategies and therapeutics.
Instructor(s): K. Rawlinson Terms Offered: TBD
Note(s): Offered at The Marine Biological Laboratory in Woods Hole, MA.

BIOS 27761. Embryology. 100 Units.
How do animals make eggs, and how to eggs make animals? How will a changing climate affect these processes? The most diverse group of animals in our oceans is the invertebrates. In this course, students will learn broad concepts in animal reproduction and development, from a biomedical, evolutionary, and climate perspective. Topics will include oogenesis, meiosis, fertilization, early development, and germ line specification, covered through morning lectures and journal club discussions of research papers. We will approach these topics through a cell biological and gene regulatory lens. In the lab, we will primarily work with the bat star Patiria miniata, but also with local sea urchin species that we will collect locally from Vineyard Sound (weather and spawning season permitting). Students will learn essential cell biological and embryological techniques including gamete and embryo/larval culture, staining, microinjection, live imaging, and cutting-edge approaches in CRISPR-Cas9 gene editing. Students will conduct independent embryology projects focusing on marine invertebrate reproduction and embryogenesis.
Instructor(s): Z. Swartz; MBL staff. Terms Offered: Spring. Spring Semester in Biological Discovery at Marine Biological Laboratory
Prerequisite(s): Second-year standing or greater (or by consent) and acceptance into the Spring Semester in Biological Discovery at MBL.

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 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, staff. 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.

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, staff Terms Offered: Winter
Prerequisite(s): BIOS 10501. NO BIOLOGICAL SCIENCES MAJORS OR NON-BIOLOGY PRE-MED STUDENTS, 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. *The Health Professions Preparation 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.*

Note: Concurrent enrollment in BIOS 20171 and BIOS 20172 is required in the second quarter of the sequence. Students who do not plan to major in Biological Sciences but cannot commit to concurrent enrollment in BIOS 20171 and 20172 should satisfy their pre-health biology requirements with courses from the Fundamentals Sequence for Biological Sciences majors (usually BIOS 20186, 20187, and 20188), two of which will count toward the general education requirement in the biological sciences.

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, C. Andrews. Terms Offered: Spring. L.
Prerequisite(s): Not open to students who have not completed BIOS 20170. Must be taken concurrently with BIOS 20172.

Biological Sciences Core Sequences for Biological Sciences Majors
Fundamentals Sequences for Biological Sciences Majors

All students who wish to major in Biological Sciences must take BIOS 20153 Fundamentals of Ecology and Evolutionary Biology and BIOS 20151 Introduction to Quantitative Modeling in Biology (Spring) to satisfy the general education requirement in the biological sciences. These courses are best taken during the first year to maximize flexibility in planning major coursework. Majors will go on to complete one of the Fundamentals Sequences which form the foundations of the Biological Sciences major (http://collegecatalog.uchicago.edu/thecollege/biologicalsciences/).

BIOS 20151. Introduction to Quantitative Modeling in Biology. 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, K. Bader. 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 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 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): Section 1: G. Dwyer, P. Muralidhar, Section 2: S. Allesina, J. Kreiner. C. Andrews, A. Hunter. Terms Offered: Winter. L.

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, Climate and Sustainable Growth, Neuroscience, Environmental Science, Geophysical Sciences, and Molecular Engineering.