

BIOLOGICAL SCIENCES

Biological sciences explore the science of life, from biomolecules to ecosystems. Courses and ongoing research programs are focused on three general areas: cell and molecular; biology; ecology; and evolution and systematics. In research laboratories, students and faculty members work together on projects that range from dinosaur evolution to an investigation of how misfolded proteins interfere with insulin production. The program has a collaboration of more than 100 years standing with the Smithsonian Institution National Museum of Natural History.

Whether they learn in the lab or at one of the dozens of agencies and museums in Washington, DC, George Washington University students have every opportunity to make biology their own. They can anchor their studies in the Smithsonian National Museum of Natural History with a collaborative program in systematics, or follow their passions to fieldwork in the Amazon Basin, the Gobi Desert, or islands in the South Pacific.

Students and researchers alike enjoy the University's cutting-edge research spaces and the Wilbur V. Harlan Greenhouse (<https://biology.columbian.gwu.edu/research-facilities/>), an open-air classroom that also grows plants for active research projects. Beyond the Foggy Bottom campus, faculty members have working relationships with scientists in surrounding educational and federal institutions, lead community service projects, and collaborate on unique initiatives with fellow scientists at institutions like the National Institutes of Health and the Food and Drug Administration.

UNDERGRADUATE

Bachelor's programs

- Bachelor of Arts with a major in biology (<http://bulletin.gwu.edu/arts-sciences/biological-sciences/ba-biology/>)
- Bachelor of Science with a major in biology (<http://bulletin.gwu.edu/arts-sciences/biological-sciences/bs-biology/>)
- Bachelor of Science with a major in neuroscience (<http://bulletin.gwu.edu/arts-sciences/biological-sciences/ba-neuroscience/>)

Combined programs

- Dual Bachelor of Science with a major in biology and Master of Science in the field of biological sciences (<http://bulletin.gwu.edu/arts-sciences/biological-sciences/combined-bs-ms/>)
- Dual Bachelor of Science with a major in neuroscience and Master of Science in the field of biological sciences (<http://bulletin.gwu.edu/arts-sciences/biological-sciences/dual-bs-neuroscience-ms-biological-sciences/>)

Minor

- Minor in biology (<http://bulletin.gwu.edu/arts-sciences/biological-sciences/minor-biology/>)

GRADUATE

Master's program

- Master of Science in the field of biological sciences (<http://bulletin.gwu.edu/arts-sciences/biological-sciences/ms/>)

DOCTORAL

Doctoral program

- Doctor of Philosophy in the field of biological sciences (<http://bulletin.gwu.edu/arts-sciences/biological-sciences/phd/>)

FACULTY

Faculty

Professors: J.M. Clark, K.A. Crandall, C.A. Forster, P. Hernandez, G. Hormiga, J.T. Lill, G. Ortí, L.C. Smith, R.P. Tollo

Associate Professors: I. Eleftherianos, A. Jeremic, D. O'Halloran, S. Powell, R.A. Pyron, A. Smith, A. Zanne

Assistant Professors: H.G. Döebel, K. Gedan, L. Grayfer, L. Hammond, C. Jordan, S. Kawano, A. Martin, M. Manier, J. Saw, T. Scully

COURSES

Explanation of Course Numbers

- Courses in the 1000s are primarily introductory undergraduate courses
- Those in the 2000s to 4000s are upper-level undergraduate courses that also may be taken for graduate credit with permission and additional work assigned
- Those in the 6000s and 8000s are for master's, doctoral, and professional-level students
- The 6000s are open to advanced undergraduate students with approval of the instructor and the dean or advising office

BISC 1000. Dean's Seminar. 3 Credits.

The Dean's Seminars provide Columbian College first-year students focused scholarship on specific intellectual challenges. Topics vary by semester; see department for more details.

BISC 1001. Departmental Seminar. 0 Credits.

BISC 1005. The Biology of Nutrition and Health. 3 Credits.

A study of the human body and food-related health issues through the examination of the nutritional needs of the human body, digestion, genetics, and life experiences/exposures. Laboratory fee. Credit cannot be earned for both BISC 1005 and BISC 1007. Credit cannot be earned for this course and BISC 1007.

BISC 1006. The Ecology and Evolution of Organisms. 3 Credits.

Introduction to ecology and evolution, including human being's impact on other plants and animals, and an overview of Earth's biodiversity. For non-majors. Credit may not be earned for both BISC 1006 and BISC 1008. Credit cannot be earned for this course and BISC 1008.

BISC 1007. Food, Nutrition, and Service. 3 Credits.

A study of biology and nutrition that uses service learning to reinforce course concepts. Topics include the need for humans to consume other organisms, processing of consumed nutrients, unexpected effects of nutritional consumption, and measures to improve nutrition. Credit cannot be earned for both BISC 1007 and BISC 1005. Credit cannot be earned for this course and BISC 1005.

BISC 1008. Understanding Organisms through Service Learning. 3 Credits.

The evolution of life on earth; the value of other organisms, their role in our world, and how humans can cause harm to this infrastructure. Students work with a community partner to perform activities that assist the partner while reinforcing course concepts. Credit may not be earned for both BISC 1008 and BISC 1006. Credit cannot be earned for this course and BISC 1006.

BISC 1099. Variable Topics. 1-36 Credits.

BISC 1111. Introductory Biology: Cells and Molecules. 4 Credits.

Nutrition and metabolism, cellular and developmental biology, genetics, and molecular biology of plants and animals. BISC 1111 is equivalent to the combination of BISC 1115 and its lab component BISC 1125. Credit cannot be earned for this course and BISC 1125.

BISC 1112. Introductory Biology: The Biology of Organisms. 4 Credits.

Concepts and methods in the study of whole organisms. Evolutionary theory; population biology; diversity of plants, animals, fungi, and microorganisms; ecology and behavior; and animal structure and function. Restricted to students in the Women's Leadership Program if registering for the WID version. Same As: BISC 1112W.

BISC 1112W. Introductory Biology: The Biology of Organisms. 4 Credits.

Concepts and methods in the study of whole organisms. Evolutionary theory; population biology; diversity of plants, animals, fungi, and microorganisms; ecology and behavior; and animal structure and function. Restricted to students in the Women's Leadership Program if registering for the WID version. Includes a significant engagement in writing as a form of critical inquiry and scholarly expression to satisfy the WID requirement. Same As: BISC 1112.

BISC 1125. Introduction to Cells and Molecules Laboratory. 1 Credit.

Laboratory associated with BISC 1115. Experimental methods in the study of cells and molecules, proteins, enzymes, DNA, and molecular genetics. BISC 1115 and BISC 1125 together are equivalent to BISC 1111. Prerequisite: BISC 1115.

BISC 1334. Bird Behavior. 4 Credits.

Topics such as migration, natural selection, sexual selection, parental care, cooperation, and communication are used to teach ecology and evolution. Labs include identifying birds in the field and data analysis.

BISC 2000. Biodiversity Studies in a Changing Planet. 3 Credits.

Biological diversity from the perspective of species and within the conceptual framework of evolutionary biology; explanatory power, simplicity, and grandeur of evolution and its products; how questions and hypotheses are empirically addressed. Prerequisites: BISC 1111 and BISC 1112.

BISC 2010. Global Change Biology. 3 Credits.

The impacts and implications of global climate change on biological systems; affected biological processes and their basic underlying physical and chemical principles. Focus on organismal physiological adaptations in aquatic and terrestrial ecosystems and ecological consequences. Prerequisites: BISC 1111 and BISC 1112.

BISC 2194. The Hidden Life of the Chesapeake Bay. 3 Credits.

The rise and fall of populations in the bay. Physiological adaptations of organisms; ecological interactions and trophic relationships; physiogeography and anthropogeography of the bay; and environmental concerns and human impacts. Credit cannot be earned for this course and GEOG 3194.

BISC 2202. Cell Biology. 3 Credits.

Structure and function of biological molecules and cellular organelles; cellular interactions. Prerequisites: BISC 1111 and BISC 1112.

BISC 2207. Genetics. 3 Credits.

Introduction to genetics, with emphasis on the integration of transmission of genetic traits and the molecular basis of gene action. Also includes cytogenetics, gene regulation, and examples of current applications of genetic technology. Prerequisites: BISC 1111 and BISC 1112.

BISC 2208. Genetics Laboratory. 1 Credit.

Study of genetic principles and genetic and molecular techniques in *Drosophila* and *E. coli*. Benchwork and comparative genomics using bioinformatics. Prerequisites: BISC 1111, BISC 1112, and BISC 2207. Corequisites: BISC 2207 may be taken concurrently.

BISC 2213. Biology of Cancer. 3 Credits.

Cancer is a complex category of diseases caused in large part by genetic or genomic, transcriptomic, and epigenomics alterations leading to abnormal cell proliferation. This course will provide a basic overview of cancer biology including cellular and molecular basis of cancer, cancer development and progression as well as a brief overview of cancer diagnostics and therapy. Prerequisites: BISC 2202 or BISC 2207.

BISC 2214. Developmental Biology. 3 Credits.

The molecular processes and cellular phenomena that result in the formation of organized tissues and functional organisms; formation of early body plan, cell type determination, organogenesis, morphogenesis, stem cells, cloning, and issues in human development. Prerequisites: BISC; BISC 1112; and BISC 2202 or BISC 2207 or BISC 2213.

BISC 2216. Scanning Electron Microscopy Laboratory. 1 Credit.

Practical training in scanning electron microscopy (SEM), from specimen preparation and mounting to SEM imaging and interpretation and presentation of data. Each student is assigned an independent research project and after receiving SEM training. Prerequisites: BISC 1111 and BISC 1112.

BISC 2220. Developmental Neurobiology. 3 Credits.

The molecular mechanisms that guide neural development: events surrounding the birth of neurons, how specific neurons are determined, how neurons find the correct targets, how cell death guides proper neural development, and how synapses are formed and maintained. Prerequisites: BISC 1115 and 1125; and BISC 1116 and BISC 1126.

BISC 2224. Biology of Horticulture. 3 Credits.

Introduction to basic concepts and skills associated with horticulture and basic botanical concepts as they apply to horticulture. The lab teaches basic plant identification skills and provides hands-on experience in GW's greenhouse facility Prerequisites: BISC 1111 and BISC 1112.

BISC 2305. Plant Biology. 3 Credits.

Plant metabolism and molecular biology: photosynthesis, nitrogen metabolism, membrane transport, mechanisms of hormone action, protein targeting, biotechnology, and current research topics. Prerequisites: BISC 1111; and BISC 1112; CHEM 1111 and CHEM 1112; or permission of the instructor.

BISC 2320. Neural Circuits and Behavior. 3 Credits.

The cellular and molecular properties of neural circuits that form the basis of behavior. Circuit properties and behaviors across a variety of invertebrate and vertebrate taxa. Individual neuronal units, the organizational principles and emergent properties of neural circuits, and how these neuronal ensembles influence behavior. Instructor's permission may be substituted for prerequisites. Prerequisites: BISC 1111; and BISC 1112.

BISC 2322. Human Physiology. 3 Credits.

Introduction to the function of organ systems of the human body. Prerequisites: CHEM 1111 and CHEM 1112; and BISC 1111 or BISC 1115 and BISC 1125; and BISC 1112 or BISC 1116 and BISC 1126.

BISC 2331. Insect Biology. 3 Credits.

Overview of the class Insecta, focusing on insect external and internal morphology, classification, ecology/behavior, collection, and specimen preparation. Prerequisites: BISC 1111 and BISC 1112.

BISC 2332. Comparative Vertebrate Anatomy. 4 Credits.

BISC 2332 provides a thorough introduction into the study of functional vertebrate anatomy. Lectures combined with intensive laboratory assignments will introduce students to the structure and function of most vertebrate organ systems. Prerequisites: BISC 1111; and BISC 1112; or permission of the instructor.

BISC 2333. Evolution and Extinction of Dinosaurs. 3 Credits.

The 165-million-year history of dinosaurs; different groups and their evolution, end-Cretaceous extinction event, the origin of birds, and the biology of the group. Prerequisites: BISC 1111 or BISC 1115 and BISC 1125, and BISC 1112 or BISC 1116 and BISC 1126; or GEOL 1001 and GEOL 1002; or GEOL 1002 and GEOL 1005. Credit cannot be earned for this course and GEOL 2333.

BISC 2334W. Integrative Biology of Fishes. 3 Credits.

Concepts in anatomy, biomechanics, physiology, developmental biology, biomechanics and hydrodynamics, adaptive radiation, evolutionary biology, and ecology using fish as model organisms. Includes a significant engagement in writing as a form of critical inquiry and scholarly expression to satisfy the WID requirement. Prerequisites: BISC 1111 or BISC 1115 and 1125; and BISC 1112 or BISC 1116 and BISC 1126.

BISC 2335. Insect Biology Lab. 1 Credit.

An overview of insects, with an emphasis on ecology, behavior, economic importance, and the key adaptations that characterize the evolution of this diverse group. This lab teaches basic internal and external anatomy, field collection methods, insect identification, and discussion of the primary literature. BISC 2331 Insect Biology must be taken either prior or concurrently with BISC 2335 Insect Biology Lab. Laboratory fee. Prerequisite: BISC 2331.

BISC 2336. Introductory Microbiology. 3 Credits.

Lecture. Survey of the major groups of microorganisms with emphasis on structure, physiology, ecology, evolution, pathogenesis, and biotechnology. Prerequisites: BISC 1111 or BISC 1115 and BISC 1125; BISC 1112 or BISC 1116 and BISC 1126; and CHEM 1111 and CHEM 1112. Same As: BISC 2337W.

BISC 2337. Introductory Microbiology Laboratory. 1 Credit.

Laboratory associated with BISC 2336. Survey of the major groups of microorganisms with emphasis on structure, physiology, ecology, evolution, pathogenesis, and biotechnology. Prerequisites: BISC 1111; BISC 1112; CHEM 1111 and CHEM 1112; and BISC 2336. Credit cannot be earned for this course and BISC 2337W.

BISC 2337W. Introductory Microbiology. 4 Credits.

Lecture (2 hours), laboratory (4 hours). Survey of the major groups of microorganisms with emphasis on structure, physiology, ecology, pathogenesis, and biotechnology. Antibiotic resistance and emerging diseases. Laboratory fee. Prerequisites: BISC 1111; and BISC 1112; and CHEM 1111 and CHEM 1112. Includes a significant engagement in writing as a form of critical inquiry and scholarly expression to satisfy the WID requirement. Credit cannot be earned for this course and BISC 2337.

BISC 2339. Parasitology. 4 Credits.

Introduction to animal parasitology; survey of parasitic types from protozoa through arthropods. Prerequisites: BISC 1111; and BISC 1112.

BISC 2401. Biodiversity in A Changing World. 3 Credits.

Topics on biological diversity from the perspective of species and within the conceptual framework of evolutionary biology. The explanatory power, simplicity, and grandeur of evolution and its products. Consideration of how questions and hypotheses are empirically addressed. Prerequisites: BISC 1111 and BISC 1112. Credit cannot be earned for this course and BISC 2000.

BISC 2450. Organic Evolution. 3 Credits.

Synthetic theory of organic evolution, including population biology, speciation, adaptation, macroevolution, systematics, biogeography, and the geologic record. Prerequisites: BISC 1111; and BISC 1112.

BISC 2451. History of Life. 3 Credits.

Overview of life through time; the origin of life, evolution of major groups of organisms, and important methodologies used in paleontology. Prerequisites: BISC 1115 and BISC 1125; and BISC 1116 and BISC 1126; or permission of the instructor. (Same as GEOL 2151)

BISC 2452. Animal Behavior. 3 Credits.

An evolutionary approach to the study of animal behavior, emphasizing behavioral ecology and sociobiology. Prerequisites: BISC 1111 and BISC 1112; or permission of the instructor.

BISC 2453. Animal Behavior Laboratory. 1 Credit.

Methods used in the study of animal behavior. Observation, basic statistical analysis, and experimental design. Review and evaluation of research materials. Prerequisites: BISC 1111 and BISC 1112. Recommended background: Prior or concurrent enrollment in BISC 2452.

BISC 2454. General Ecology. 3 Credits.

The core concepts of the field of ecology across different hierarchical scales of ecological systems. Prerequisites: BISC 1111 and BISC 1112; or permission of the instructor.

BISC 2456. General Ecology Laboratory. 1 Credit.

Practical exercises and field-trips are used to explore the core concepts of the field of ecology across different hierarchical scales of ecological systems. Laboratory fee. Prerequisites: BISC 1111 and BISC 1112; and BISC 2454 taken previously or concurrently.

BISC 2581. Human Gross Anatomy. 3 Credits.

The structural and functional organization of the human body, focusing on organ systems-based functions. Clinical applications are used to demonstrate the importance of regional anatomical relationships and their interplay with functional systems. Prerequisites: BISC 1111 and BISC 1112 or with permission of the instructor. Same As: ANAT 2181.

BISC 2583. Biology of Proteins. 3 Credits.

About half of the proteins in the human genome have unknown functions. Are some related to cancers, muscle degeneration, infectious disease? How can evolutionary relationships among proteins from other organisms help us discover functions of unknown proteins? Laboratory fee. Prerequisite: AP or IB Biology or Chemistry.

BISC 2584. Introduction to Bioinformatics. 3 Credits.

The use of computational techniques in molecular biology, genetics, and evolution; techniques and software for database searching, sequence alignment, gene finding, phylogenetics, genomics, and proteomics. Prerequisites: BISC 1111 and BISC 1112. Same As: CSCI 3571.

BISC 2585. Biometry. 3 Credits.

The application of statistics to problems in biology, including experimental and field work and environmental science and biometry. Designed for program majors. Prerequisites: MATH 1220. Recommended background: Familiarity with basic command-line applications and introductory calculus.

BISC 3099. Variable Topics. 1-12 Credits.**BISC 3122. Human Physiology. 3 Credits.**

Introduction to the function of organ systems of the body. Prerequisites: CHEM 1111 and CHEM 1112; and BISC 2202 or BISC 2207.

BISC 3123. Human Physiology Lab. 1 Credit.

Basic physiology laboratory techniques; emphasis on the experimental study of homeostatic mechanisms in humans. Laboratory fee. Prerequisites: BISC 1111 and BISC 1112.

BISC 3165. Biochemistry I. 3 Credits.

Introduction to the chemistry of living cells; structure and function of proteins, lipids, carbohydrates, and nucleic acids; enzyme structure, mechanism, and regulation. Prerequisites: BISC 1115 and BISC 1125; and BISC 1116 and BISC 1126, CHEM 2151 and CHEM 2152; course equivalents may be substituted for BISC 1115 and 1125; and BISC 1116 and BISC 1126 at the discretion of the instructor. Same As: CHEM 3165.

BISC 3166. Biochemistry II. 3 Credits.**BISC 3167. Biochemistry Laboratory. 2 Credits.**

Practice and theory of modern biochemistry and chemical biology laboratory techniques used to study biological macromolecules and their interactions with drugs and small molecules. Prerequisites: BIOC 3261, or BISC 3261, or CHEM 3165. Same As: CHEM 3167.

BISC 3208. Molecular Biology Laboratory. 1 Credit.

Techniques in molecular biology; traditional and modern methods in recombinant DNA technology, gene and protein characterization methods. Prerequisites: BISC 1111; BISC 1112; and CHEM 1111 and CHEM 1112.

BISC 3209. Molecular Biology. 3 Credits.

Theories and concepts in molecular biology; biosynthesis and structure of DNA, RNA, and proteins, relationships among gene function and expression; transcription and translation; regulation of gene expression in prokaryotes and eukaryotes; theory of traditional and modern methods in recombinant DNA technology, gene and protein characterization methods. Prerequisites: BISC 1111; BISC 1112; and CHEM 1111 and CHEM 1112.

BISC 3210. Nanobiotechnology. 3 Credits.

Theory and application of nanotechnologies in biology and medicine. Strategies for studying the organization, function, and complexity of biological systems at nanometer scale. Several areas of research are covered, including high-resolution cellular and molecular imaging, spectroscopy, and optical tweezers. Prerequisites: BISC 2202 or BISC 3261.

BISC 3211. Nanobiotechnology Laboratory. 1 Credit.

Modern instrumental techniques for analyzing biological structures and processes at the nanometer level; combining nano- and conventional techniques to answer scientific questions. Students formulate, design, and implement a research project. Prerequisites: BISC 1111 or BISC 1115 and BISC 1125; and BISC 1112 or BISC 1116 and BISC 1126.

BISC 3212. Immunology. 3 Credits.

Introduction to mammalian immunology covering the progression of immune responses from initial pathogen contact to immune memory. Prerequisites: BISC 1111; BISC 1112; BISC 2202 or BISC 2207; and CHEM 1111 and CHEM 1112. Recommended background: prior completion of CHEM 2151 and CHEM 2153.

BISC 3214. Developmental Biology. 3 Credits.

The molecular processes and cellular phenomena that result in the formation of organized tissues and functional organisms; formation of early body plan, cell type determination, organogenesis, morphogenesis, stem cells, cloning, and issues in human development. Prerequisites: BISC 1111 or BISC 1115 and BISC 1125; BISC 1112 or BISC 1116 and BISC 1126; and BISC 2202 or BISC 2207 or BISC 2213. Same As: BISC 2214.

BISC 3215. Genome Editing Laboratory. 3 Credits.

Practical training in genome editing in, from sequence design to molecular biology, generation of edited animals, and phenotypic analysis. Students undertake individual research projects involving CRISPR. Prerequisites: BISC 1111 and BISC 1112; and BISC 2202 or BISC 2207. Same As: BISC 3215W.

BISC 3215W. Genome Editing Laboratory. 3 Credits.

Practical training in genome editing in, from sequence design to molecular biology, generation of edited animals, and phenotypic analysis. Students undertake individual research projects involving CRISPR. Prerequisites: BISC 1111 and BISC 1112; and BISC 2202 or BISC 2207. Includes a significant engagement in writing as a form of critical inquiry and scholarly expression to satisfy the WID requirement. Same As: BISC 3215.

BISC 3261. Introductory Medical Biochemistry. 4 Credits.

Introduction to structures of biological macromolecules, enzyme catalysis, cellular bioenergetics, and metabolism. Prerequisite: CHEM 2151 and CHEM 2152. Same As: BIOC 3261.

BISC 3262. Biochemistry Laboratory. 2 Credits.

Study of common experimental techniques used in life science laboratories to separate and characterize biological macromolecules. Same as BISC 3262 and CHEM 3262. Laboratory fee. Prerequisites: BIOC 3261 or BISC 3261.

BISC 3263. Special Topics in Biochemistry. 2 Credits.

In-depth discussion of current biochemically relevant topics, including cancer and HIV chemotherapy, immune response, photosynthesis, signal transduction, hormone regulation, and nutrition. Topics vary by semester. May be repeated for credits provided topic differs. Consult the Schedule of Classes for more details. Prerequisites: BISC 1111; BISC 1112; and BISC 3261. Credit cannot be earned for this course and BIOC 3263.

BISC 3270. Developmental Neurobiology. 3 Credits.

Fundamental principles of neural development organized by ontogeny, from early neural development to patterning, axonal targeting, and synapse formation. Prerequisites: BISC 1111 or BISC 1115 and BISC 1125; and BISC 1112 or BISC 1116 and BISC 1126. Same As: BISC 2220.

BISC 3320. Human Neurobiology. 3 Credits.

Introduction to the function of the human nervous system, gross and microscopic structure, and neurophysiology of the brain, spinal cord, and nerves; alterations caused by disease or injury. Prerequisites: BISC 2202 or BISC 3261.

BISC 3450. Evolutionary Medicine. 3 Credits.

The application of evolutionary principles, including natural selection, adaptation, phylogenetics, and evolutionary constraints, to understanding health, disease, and the biology of disease-causing organisms (viruses, bacteria, and parasites). How natural selection and phylogeny influence pathogen-host interactions, human genetics, immunology, development, cancer, and diseases of senescence. Prerequisites: BISC 1111 and BISC 1112. Recommended background: BISC 2207 and BISC 2450. Same As: BISC 3450W.

BISC 3450W. Evolutionary Medicine. 3 Credits.

The application of evolutionary principles, including natural selection, adaptation, phylogenetics, and evolutionary constraints, to understanding health, disease, and the biology of disease-causing organisms (viruses, bacteria, and parasites). How natural selection and phylogeny influence pathogen-host interactions, human genetics, immunology, development, cancer, and diseases of senescence. Prerequisites: BISC 1111 and BISC 1112. Recommended background: BISC 2207 and BISC 2450. Includes a significant engagement in writing as a form of critical inquiry and scholarly expression to satisfy the WID requirement. Same As: BISC 3450.

BISC 3453. Plant Comparative Structure and Function Lab. 2 Credits.

Core concepts and techniques in comparative plant structure and function. Prerequisites: BISC 2454. Recommended background: Concurrent enrollment in BISC 3458.

BISC 3454. Marine Ecology. 3 Credits.

Abiotic and biotic factors in marine environments in general and ecological theory behind how they shape communities, biomes, and patterns in marine biodiversity; major marine habitats and the important organisms, physical environment, and major interactions in each; threats to marine environments and effective conservation strategies.

BISC 3455. Marine Ecology Laboratory. 1 Credit.

Study of marine ecology through experiential learning and an introduction to ecological research in the marine environment and using large datasets collected by marine scientists. By visiting marine ecosystems, students learn about marine resource use and conservation strategies in the coastal zone.

BISC 3458. Plant Comparative Structure and Function. 3 Credits.

Fundamental principles of how organisms are built, investigating trade-offs and coordination in design, how variation in structure influences physiological function in different ecological settings, and how relations among plants shape structure and function and responses to ecological gradients. Prerequisites: BISC 1111; BISC 1112; or permission of instructor. Recommended background: BISC 2454 General Ecology.

BISC 3459. Field Biology. 4 Credits.

Overview of the approaches and techniques used by contemporary field biologists for cataloging, quantifying, and comparing patterns of biodiversity across plants, animals, and fungi at multiple spatial and temporal scales. Prerequisites: BISC 1111 and BISC 1112. Recommended background: Prior completion of BISC 2454.

BISC 3460. Conservation Biology. 3 Credits.

Theory and practice of conserving biological diversity. Ecological patterns of biodiversity, biology of small populations, and conservation case studies. Use of ecological modeling software to explore various topics. Prerequisites: BISC 1111; BISC 1112.

BISC 3460W. Conservation Biology. 3 Credits.

Theory and practice of conserving biological diversity. Ecological patterns of biodiversity, biology of small populations, and conservation case studies. Use of ecological modeling software to explore various topics. Includes a significant engagement in writing as a form of critical inquiry and scholarly expression to satisfy the WID requirement. Prerequisites: BISC 1111 or BISC 1115 and BISC 1125; and BISC 1112 or BISC 1116 and BISC 1126. Same As: BISC 3460.

BISC 3461. Plant-Animal Interactions. 3 Credits.

Review of the major ecological and evolutionary interactions that occur between plants and animals in natural and managed ecosystems. Prerequisites: BISC 1111; BISC 1112; or permission of the instructor. Recommended background: BISC 2450 or BISC 2454.

BISC 3462. Plant-Animal Interactions Laboratory. 1 Credit.

Field and laboratory study of temperate interactions between plants and animals. Group projects focus on original data collection, analysis, and interpretation. The stated prerequisites may be taken as corequisites; consult the instructor. Laboratory fee. Prerequisites: BISC 1111; BISC 1112; and BISC 3461.

BISC 3463. Ecological and Evolutionary Genetics. 3 Credits.

An analysis of the ecological and genetic basis of evolutionary change. Topics include the organization and maintenance of genetic variation within and among natural populations, the genetic basis of complex traits, molecular ecology analyses, and genotype by environment interactions. Prerequisites: BISC 2450 or permission of instructor; BISC 1111; BISC 1112; except by permission of the instructor.

BISC 3464. Ecology and Evolution of Societies. 3 Credits.

Study of broadly important ecological and evolutionary patterns and processes exemplified by organisms that have undergone the major evolutionary transition to living in societies. Prerequisites: BISC 1111; BISC 1112. Recommended background: Prior completion of BISC 2454.

BISC 3465. Restoration Ecology. 3 Credits.

Restoration ecology takes knowledge of how organisms interact with each other and their environment and uses it to engineer functioning ecosystems in disturbed and polluted habitats. Prerequisites: BISC 1111 and BISC 1112.

BISC 3565. Plant Ecology and Evolution. 3 Credits.

How plants are built; how this construction shapes their physiological function in different ecological settings; how plants are related revolutionarily, and how these relations shape their structure, function, and responses to their environment. Prior completion of BISC 2454 is recommended. Prerequisites: BISC 1111; BISC 1112; or permission of the instructor.

BISC 3584. Introduction to Bioinformatics. 3 Credits.

The use of computational techniques in molecular biology, genetics, and evolution; techniques and software for database searching, sequence alignment, gene finding, phylogenetics, genomics, and proteomics. Prerequisites: BISC 1115 and 1125; and BISC 1116 and BISC 1126. Same As: CSCI 3571.

BISC 4100W. Writing in the Life Sciences. 3 Credits.

The fundamentals of literature searching, scientific writing, and presentation of research in the life sciences. Particularly recommended for students undertaking undergraduate research or preparing an honors thesis. Includes a significant engagement in writing as a form of critical inquiry and scholarly expression to satisfy the WID requirement.

BISC 4132. Advanced Cellular-Molecular Biology. 3 Credits.

Advanced cell biology with emphasis on biochemistry and molecular biology; illustrations are drawn from different organisms and human biology. For upper-level undergraduates and beginning graduate students. Permission of the instructor required prior to enrollment. Prerequisite: BISC 3209. Recommended background: Six credits in the Cellular and Molecular category.

BISC 4171. Undergraduate Research. 1-12 Credits.

Admission by permission of the staff member concerned. May be repeated for credit. Laboratory fee. Prerequisites: BISC 1111 and BISC 1112 except by permission of the instructor; 16 credits in biological science courses.

BISC 4171W. Undergraduate Research. 1-12 Credits.

Admission by permission of the staff member concerned. May be repeated for credit. Laboratory fee. Includes a significant engagement in writing as a form of critical inquiry and scholarly expression to satisfy the WID requirement. Prerequisites: BISC 1115 and BISC 1125; and BISC 1116 and BISC 1126; and CHEM 2152 except by permission of the instructor; 16 credits in biological science courses.

BISC 4172. Independent Study. 1-3 Credits.

Prescribed reading list and consultations with staff advisor culminating in a written report and/or examination. Prerequisites: BISC 1111; and BISC 1112; and permission of the instructor.

BISC 4180. Undergraduate Research Seminar. 1 Credit.

Preparation for writing in diverse areas of modern biology; development of the skills needed to effectively communicate findings, publish research, and successfully obtain research funding. Same As: BISC 4180W.

BISC 4180W. Undergraduate Research Seminar. 1 Credit.

Preparation for writing in diverse areas of modern biology; development of the skills needed to effectively communicate findings, publish research, and successfully obtain research funding. Includes a significant engagement in writing as a form of critical inquiry and scholarly expression to satisfy the WID requirement. Same As: BISC 4180.

BISC 4212. Virology and Antiviral Immunity. 3 Credits.

Comprehensive overview of the infection, replication, and immune evasion strategies of distinct classes of viruses; hands-on survey into the molecular techniques in virology. Prerequisites: BISC 2202 or BISC 2207 or BISC 3209 or BISC 3212. Credit cannot be earned for this course and BISC 6212.

BISC 4213. Virology and Antiviral Immunity Lab. 1 Credit.

Lab component designed to familiarize students with the current experimental approaches in molecular biology used to study host immune interactions with viral pathogens. Course equivalents to stated prerequisite may be permitted by the instructor. Prerequisites: BISC 2202 or BISC 2207; and BISC 3209 and BISC 3212.

BISC 4218. Innate Immunity. 3 Credits.

Non-mammalian immune systems. Students gain an in-depth understanding of the breadth of immunological strategies currently known across the animal kingdom. Prerequisites: BISC 1111 and BISC 1112; and BISC 2202 or equivalent; and BISC 3212 or equivalent. Same As: BISC 6218.

BISC 4219. Host-Microbe Interactions. 3 Credits.

Overview of the molecular, genetic, cellular and physiological basis of symbiotic and pathogenic interactions between plants, invertebrate and vertebrate animals with various microbial organisms including bacteria, fungi, viruses as well prokaryotic and eukaryotic parasites. Prerequisites: BISC 2202 and BISC 2337. Credit cannot be earned for this course and BISC 6219.

BISC 4234. Microbial Genomics Laboratory. 3 Credits.

Development of computational skills needed to analyze microbial genomes and metagenomes. In addition to the prerequisite course, either basic understanding of Unix/Linux commands or permission of the instructor is prior to enrollment. Prerequisites: BISC 2336. Same As: BISC 6234.

BISC 5099. Variable Topics. 1-99 Credits.**BISC 6101. Responsible Research. 1 Credit.**

This course provides an introduction to the ethical, social, and legal foundations of scientific practice. It is intended to provide a forum for graduate students and postdocs to discuss almost every aspect of the academic life of a scientist, except specific disciplinary topics that are treated in regular courses. Ensuring ethical conduct is an essential part of basic, applied, and clinical research, especially in the context of competitive, collaborative, and international settings so common nowadays. Students are exposed to case studies typifying complex social, ethical, and legal dilemmas that may arise in the conduct of research.

BISC 6102. Scientific Presentation. 1 Credit.

This course allows students to perfect their Scientific Presentation skills. In this course, students present, in front of peers and faculty, their current research projects and plans for future work leading towards a complete thesis or dissertation. Student presentations are designed to address a general audience of biologists, containing sufficient background information to provide perspective insights into the fundamental questions being asked, and at the same time providing enough detail on technical issues and analytical procedures to allow evaluation of potential outcomes. The class provides a friendly forum for students to collect feedback and comments, to discuss project design, content, and general significance of their research.

BISC 6103. Professional Development. 2 Credits.

Provides comprehensive career guidance in biological research, encompassing research principles, professional skills, effective communication, and strategic career planning across academia, industry, and government sectors. Restricted to graduate students.

BISC 6132. Advanced Cellular-Molecular Biology. 3 Credits.

Advanced cellular biology for upper-level undergraduates and beginning graduate students; emphasis on biochemistry and molecular biology; organisms and human biology with emphasis on oral and written analysis of research literature. Permission of the instructor required prior to enrollment. Restricted to students who have completed 16 credits of 2000-4000 level biology courses, including 6 credits in the cell and molecular category. Prerequisites: Graduate standing or undergraduates with 16 credits of 2000-4000 level biology courses, including 6 credits in the Cell and Molecular category and permission of instructor. Recommended background: 4 to 6 upper level biology courses, including 2 cell and molecular courses. Credit cannot be earned for this course and BISC 4132.

BISC 6205. Foundations in Cell and Molecular Biology. 3 Credits.

The cellular mechanisms that control the production, transport, and breakdown of different cellular components. Prerequisites: Prior coursework in organic chemistry or biochemistry.

BISC 6206. Current Topics in Evolutionary Ecology. 1-2 Credits.

May be repeated for credit.

BISC 6207. Seminar: Current Topics in Systematic Biology. 1-2 Credits.

Topics vary by semester. See the Schedule of Classes for more details. May be repeated for credit provided the topic differs.

Prerequisite: BISC 6210.

BISC 6210. Methods of Study of Evolution. 4 Credits.

A rigorous and up-to-date treatment of the theory and methods of systematics, including phylogenetic inference and its applications in evolutionary biology. Laboratory fee. Prerequisite: BISC 2450 .

BISC 6211. Biogeography and Speciation. 3 Credits.

Survey of methods, techniques, and theory in biogeography. Geological and paleontological aspects of biogeography; large-scale biogeographic patterns; speciation and phylogeography. Prerequisites: BISC 2451 or BISC 2452.

BISC 6212. Virology and Antiviral Immunity. 3 Credits.

Overview of the infection, replication, and immune evasion strategies of distinct classes of viruses, as well the host antiviral immune responses to these pathogens. Credit cannot be earned for this course and BISC 4212.

BISC 6213. Descriptive Systematics: Documenting Biodiversity. 3 Credits.

Study of those aspects of systematic biology concerned with description and inventory of biodiversity. Prerequisite: BISC 6210.

BISC 6214. The Phylogenetic Basis of Comparative Biology. 3 Credits.

The use of phylogenetic hypotheses to study questions in evolutionary biology and ecology. Prerequisites: BISC 6210 and STAT 1127.

BISC 6215. Vertebrate Phylogeny. 4 Credits.

A survey of vertebrate diversity, emphasizing evolutionary relationships and adaptations of the major groups. Prerequisite: BISC 2450. Recommended background: BISC 2332.

BISC 6216. Morphological Systematics. 3 Credits.

Methods of studying organismal morphology as a means of inferring phylogeny, emphasizing the concept of homology. Prerequisite: BISC 6210.

BISC 6218. Innate Immunity. 3 Credits.

Discussion of innate immune systems in a wide variety of organisms; from sponges to vertebrates plus higher plants. Prerequisites: BISC 3212. Recommended background: BISC 2202, BISC 2207, BISC 3209 and BISC 2330.

BISC 6219. Host-Microbe Interactions. 3 Credits.

Overview of the molecular, genetic, cellular, and physiological basis of symbiotic and pathogenic interactions between plants, invertebrate, and vertebrate animals with various microbial organisms including bacteria, fungi, viruses as well prokaryotic and eukaryotic parasites. Prerequisites: BISC 2202 and BISC 2337.

BISC 6224. Molecular Evolution. 3 Credits.

BISC 6225. Molecular Phylogenetics. 4 Credits.

Review of molecular phylogenetic methods including data recovery, alignment, weighting, character optimization, and phylogenetic inference methods. Prerequisites: BISC 2207, BISC 2450 and BISC 6210.

BISC 6227. Seminar: Genetics. 3 Credits.

Review of selected topics in genetics, with emphasis on current literature; topics of special interest to participants encouraged. May be repeated for credit. Prerequisite: BISC 2207.

BISC 6228. Population Genetics. 3 Credits.

Origin, maintenance, and possible significance of genetic variation in populations. Selection, genetic drift, and population structure are emphasized. Both theoretical and applied aspects of population genetics are discussed. Same as FORS 6247. Prerequisite: BISC 2207.

BISC 6230. Human Genetics. 3 Credits.

Genetic mechanisms of transmission and expression of human traits, with emphasis on biochemical and cytogenetic aspects. Prerequisite: BISC 2207. Recommended background: Previous coursework in cell biology or cell biochemistry.

BISC 6232. Organismal Form and Function. 3 Credits.

Overview of organismal form and function through the lens of comparative biomechanics and morphology, with an emphasis on animals. Restricted to graduate students.

BISC 6234. Microbial Genomics Laboratory. 3 Credits.

Development of computational skills needed to analyze microbial genomes and metagenomes. In addition to the prerequisite course, either basic understanding of Unix/Linux commands or permission of the instructor is prior to enrollment. Prerequisites: BISC 2336. Same As: BISC 4234.

BISC 6238. Foundations of Ecology. 3 Credits.

We will review foundational concepts and theories that have shaped the scientific discipline of ecology by reading and discussing classic papers and/or synthetic reviews of important topics. Restricted to This course is designed for early career graduate students (MS, PhD) and advanced undergraduates with research/career interests in ecology-related topics. Recommended background: research/career interests in ecology-related topics.

BISC 6243. Seminar: Ecology. 3 Credits.

In-depth study of selected topics, including reports on original publications. May be repeated for credit. Prerequisite: BISC 2454.

BISC 6251. Evolutionary Developmental Biology. 3 Credits.

Developmental mechanisms involved in the morphological changes that occur during the course of evolution.

BISC 6252. Seminar: Neurobiology. 3 Credits.

Study of current publications in functional neurobiology. May be repeated for credit with instructor's permission.

BISC 6274. Gene Regulation and Genetic Engineering. 3 Credits.

The control of gene expression as illustrated by several prokaryotic and eukaryotic model systems: discussions of recombinant DNA techniques. Prerequisite: BISC 2207.

BISC 6275. Introduction to Recombinant DNA Techniques. 3 Credits.

Lecture, 1 hour; laboratory, 4 hours. Basic techniques of genetic manipulation: cloning of genes, transformation of bacteria, PCR procedures, DNA sequencing, and other techniques. Prerequisite: BISC 2202 or BISC 2207 or BISC 2337 and permission of instructor. Laboratory fee.

BISC 6276. Foundations in Evolution. 3 Credits.

Rigorous introduction to the major conceptual area within micro- and macroevolution. Restricted to graduate students. Prerequisites: BISC 2450.

BISC 6295. Research. 1-12 Credits.

Investigation of special problems. May be repeated for credit.

BISC 6999. Thesis Research. 3,6 Credits.

Development of a thesis project and accompanying research. May be repeated for credit. Restricted to students in the MS in biological sciences program.

BISC 8998. Advanced Reading and Research. 1-12 Credits.

For students preparing for the doctor of philosophy general examination. May be repeated for credit. Restricted to PhD students.

BISC 8999. Dissertation Research. 3-12 Credits.

May be repeated for credit. Restricted to Biological Science PhD students in only.