BIOLOGY

Chair: Greta Binford
Administrative Coordinator: Rian Brennan

Biologists examine life on our planet from many different perspectives, from molecules to ecosystems. At Lewis & Clark, students explore the many facets of biological science through a diverse and innovative curriculum that encourages original thinking and provides hands-on experience at all levels of biological inquiry. From their first course, biology majors are immersed in the process of discovery, developing the skills of logical problem-solving and rigorous methodology that characterize modern scientific investigation. Students are not only introduced to facts, but to the theoretical underpinnings that define a particular topic and its relevance in today’s world. Thus, graduates leave the program prepared for a variety of careers. Some pursue graduate studies and go on to become researchers, teachers, or health professionals. Others enter careers in law, journalism, education, or business. The concern of many majors for the health of our planet leads to environmental careers in academia or with governmental agencies, businesses, or private foundations.

The faculty in the Department of Biology believe strongly in the value of learning through experience, and most courses include laboratory sections that support students as they develop their own investigations.

Students are encouraged to spend at least one summer gaining research experience, either by working with a Lewis & Clark faculty member or through one of the many available research internship programs at laboratories and field stations throughout the country.

Special Programs

Biology majors may participate in research programs with biology faculty at Lewis & Clark or with research professionals at other local institutions. These opportunities are available to students who have a strong academic record. Two semester credits may be earned through BIO 244 Practicum if the student works under the close guidance of a faculty member; up to 4 hours per semester may be earned for BIO 499 Independent Study if the student has sufficient familiarity with research to work fairly independently on the design, execution, and interpretation of experiments.

Two interdisciplinary majors are available for students with interests linking biology with other disciplines: biochemistry/molecular biology and environmental studies. For more information, please refer to Biochemistry and Molecular Biology and Environmental Studies in this catalog.

Resources for Nonmajors

Students majoring in other subjects may enroll in BIO 100 Perspectives in Biology or BIO 115 Explorations in Regional Biology, which have no prerequisites, or BIO 114 The Origins of Life in the Universe. These courses are designed to meet one of the General Education requirements in scientific and quantitative reasoning. Nonmajors may also take other biology courses for which they have met the appropriate prerequisites, but priority for enrollment in these courses is given to prospective biology, environmental studies, or biochemistry and molecular biology majors and pre-health professions students.

Facilities

Biology department resources used by students in classes and independent projects include DIC, fluorescence and time-lapse deconvolution microscopes, a climate-controlled greenhouse, and oxygen and carbon dioxide gas-exchange analyzers. Molecular biology laboratories are equipped for gene cloning, polymerase chain reaction, tissue culture, and protein-separation activities. Areas near campus such as Tryon Creek State Natural Area (http://oregonstateparks.org/park_144.php) offer convenient sites for field studies.

The Major Program

The biology curriculum at Lewis & Clark is built around an introductory sequence of three courses, each of which introduces students to the principles and skills that are fundamental to all of biology. Through topics and examples centered on faculty expertise, students will learn to pose and answer questions about living systems—begin to function as biologists—very early in their college careers. In addition to the core courses in biology, majors are expected to complete at least a year’s study of chemistry and a college-level course in calculus, computer science, or statistics because biology draws on the techniques and knowledge from these other scientific disciplines. Students complete the major by choosing, with the help of their faculty advisors, the upper-division courses in biology that best serve their personal interests.

Major Requirements

A minimum of 40 semester credits in biology (or approved alternatives), plus courses in chemistry and mathematics, distributed as follows:

- BIO 110 Biological Investigations
- BIO 201 Biological Core Concepts: Systems
- BIO 202 Biological Core Concepts: Mechanisms
- CHEM 110 General Chemistry I
- CHEM 120 General Chemistry II
- One of the following:
  - MATH 123 Calculus & Statistics for Modeling the Life Sciences
  - MATH 131 Calculus I
  - MATH 255 Statistical Concepts and Methods
  - CS 171 Computer Science I
- Six additional courses, at least four of which must have a laboratory component, and at least four of which must be taken at Lewis & Clark.
  - CHEM 330 Structural Biochemistry and/or CHEM 335 Metabolic Biochemistry may be used as nonlab biology courses toward meeting this requirement, and CHEM 330 Structural Biochemistry and CHEM 336 Biochemistry Laboratory or CHEM 335 Metabolic Biochemistry and CHEM 336 Biochemistry Laboratory may be used as lab courses. The two semesters of senior thesis may be used as one lab course.

Biology majors may be able to substitute one of the following courses after consultation with the advisor and with permission of the biology chair.

- CHEM 220 Organic Chemistry II
- MATH 123 Calculus & Statistics for Modeling the Life Sciences
- MATH 255 Statistical Concepts and Methods

All Lewis & Clark courses intended to fulfill the requirements for the biology major must be taken for a letter grade with the exception of BIO 395 Biology Seminar, for which up to two credits may be applied to the biology major. Majors are strongly encouraged to take additional courses in chemistry, mathematics, computer science, and physics.
For students who have earned a 5 on the AP Chemistry examination, the CHEM 110 requirement and associated credits will be waived.

**Honors**

Biology majors who have distinguished themselves academically by earning a GPA of at least 3.500 in the major are eligible to participate in the honors program. In the spring of their junior year, students work with a faculty advisor to develop a research proposal, which must be approved by the department. Students carry out the experimental work in their senior year, preparing a written thesis and an oral presentation for the faculty during the spring semester. The senior thesis may be used as one of the six upper-division biology courses required for the major. Students who maintain a GPA of at least 3.500 in the major and who complete the program successfully in the judgment of the department faculty receive honors in biology upon graduation.

**Faculty**


**Courses**

**BIO 100 Perspectives in Biology**

Content: For nonmajors. Selected current topics in biology used to illustrate the strengths and limitations of the process of science and the approaches biologists use to learn about living organisms. Emphasis changes from semester to semester, reflecting the expertise and interests of the faculty member teaching the course. For further information, consult the appropriate faculty member before registration. Lecture and laboratory. May not be applied toward the biology major. Prerequisites: None.

Usually offered: Annually, fall and spring semester. Semester credits: 4.

**BIO 110 Biological Investigations**

Content: Introduction to scientific investigation through project-based studies of biological phenomena. Topics in this hands-on course introduce students to experimental design, data collection, data analysis, hypothesis testing, and scientific communication. Topics will vary according to faculty expertise. See department website for specific section details. Prerequisites: QR 101 or equivalent. Restrictions: Open to freshmen and sophomores. Juniors and seniors require instructor consent. Usually offered: Annually, fall and spring semester. Semester credits: 4.

**BIO 114 The Origins of Life in the Universe**

Content: Processes of stellar evolution and planet formation that set the stage for life on Earth. Theories and evidence from diverse scientific disciplines on the origins of life and how physical and chemical aspects of the environment contributed to the emergence and transformations of life forms. Scientific evaluation of the possibility of extraterrestrial life. Attention is devoted both to the processes and content of scientific discovery. Lecture, discussion, laboratory. Cross-listed with CHEM 114, GEOL 114, and PHYS 114. Not applicable toward any major. Prerequisites: QR 101 or equivalent. Usually offered: Alternate Years, spring semester. Semester credits: 4.

**BIO 115 Explorations in Regional Biology**

Content: For nonmajors. Offered in association with selected overseas programs. Selected biological principles using biomes and species native to the geographical location of the program. Emphasis on ecology and behavior of living organisms. Classroom and considerable field experience. Specific content varies from program to program; details available from Office of Overseas and Off-Campus Programs. Taught on the Australia, East Africa, Ecuador, and New Zealand study programs. May not be applied toward the biology major. Prerequisites: None. Restrictions: Acceptance to overseas program. Usually offered: Alternate Years, fall and spring semester. Semester credits: 4.
BIO 201 Biological Core Concepts: Systems
Content: An introduction to core principles that underlie all of biology, illustrated through evidence-driven examples centered on integrative organismal biology and organisms' interactions with the biotic and physical environment. We will explore the evolution of life, flow of information within and among individuals, the influence of structure on function at scales from individuals to ecosystems, the transformations of energy and matter in space and time, and the dynamic systems that characterize Earth and its inhabitants. Topics will vary according to faculty expertise. See department website for specific section details. Can be taken before or after BIO 202.
Prerequisites: BIO 110.
Restrictions: Open to freshmen and sophomores. Juniors and seniors require instructor consent.
Usually offered: Annually, fall and spring semester.
Semester credits: 4.

BIO 202 Biological Core Concepts: Mechanisms
Content: An introduction to core principles that underlie all of biology, illustrated through evidence-driven examples centered on interactions among molecules and cells within organisms. We will explore mechanisms of inheritance and mutation fundamental to the evolution of life, flow of information from DNA through proteins to cellular and organismal function, the relationship between structure and function at scales from molecules to individuals, the transformations of energy and matter through biochemical and physiological pathways, and the dynamic systems within and between cells. Topics will vary according to faculty expertise. See department website for specific section details. Can be taken before or after BIO 201.
Prerequisites: BIO 110. CHEM 120 (may be taken concurrently).
Restrictions: Open to freshmen and sophomores. Juniors and seniors require instructor consent.
Usually offered: Annually, fall and spring semester.
Semester credits: 4.

BIO 244 Practicum
Content: Supervised practical experience in lab and/or field techniques at Lewis & Clark or another Portland-area institution. Consult department faculty for further information. Credit-no credit. May be repeated for credit.
Prerequisites: None.
Restrictions: Sophomore standing and consent required.
Usually offered: Annually.
Semester credits: 4.

BIO 252 Introduction to Neuroscience
Content: Study of the biological basis of behavior. Gross anatomy of the brain, structure and function of neurons, synaptic transmission. Exploration of learning and memory, vision, neurological and psychiatric diseases, addiction, and reproductive behavior. Cross-listed with PSY 252. Students may not receive credit for both BIO/PSY 252 and PSY 280.
Prerequisites: BIO 110 and PSY 100.
Restrictions: Sophomore standing required.
Usually offered: Annually, fall semester.
Semester credits: 4.

BIO 311 Molecular Biology
Content: Advanced study of the structure and function of genes. Detailed analysis of the regulation of gene expression in prokaryotic and eukaryotic organisms, with emphasis on the molecular mechanisms underlying such biological problems as iron homeostasis, HIV infection, and sex determination. Discussions of original research papers focus on experimental design and data analysis.
Prerequisites: BIO 110. BIO 202. CHEM 120.
Corequisites: BIO-312.
Restrictions: Sophomore standing required.
Usually offered: Annually, fall semester.
Semester credits: 4.

BIO 312 Molecular Biology Lab
Content: Introduction to molecular cloning techniques, including the polymerase chain reaction, plasmid construction, transformation, and DNA sequence analysis. Students carry out a semester-long project using these techniques to construct an expression vector that is used to answer student-generated questions.
Prerequisites: BIO 110. BIO 202. CHEM 120.
Corequisites: BIO-311.
Restrictions: Sophomore standing required.
Usually offered: Annually, fall semester.
Semester credits: 2.

BIO 317 Invertebrate Zoology
Content: The diversity of invertebrates, with emphasis on the arthropods. Introduction to their structure, development, behavior, natural history, and evolutionary relationships. Lecture, discussion, laboratory, field trips.
Prerequisites: BIO 110, BIO 201, and BIO 202.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years, fall semester.
Semester credits: 5.

BIO 320 Human Genes and Disease
Content: The molecular and cellular basis of various genetic diseases, the role of genes in disease, how mutations arise, and approaches to therapy. Ethical issues surrounding gene therapy and DNA diagnostics. Lectures, discussion of papers from the primary literature, and seminars by visiting scientists. Students develop and present an oral seminar on a disease of their choice.
Prerequisites: BIO 110. BIO 202.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years, fall semester.
Semester credits: 4.

BIO 321 Marine Biology
Content: Physical, chemical, and biological processes that promote and maintain marine biodiversity. An exploration of ecological and evolutionary mechanisms at work within marine environments, with emphasis on natural-selection processes that produce specific physiological adaptations, body types, and behavioral strategies for a wide range of marine organisms and habitats. Lecture, discussion.
Prerequisites: BIO 110, BIO 201 and BIO 202. MATH 115 (or equivalent) or CS 171.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years, fall and spring semester.
Semester credits: 4.
BIO 323 Plant Biology
Content: Key concepts of plant biology, including morphology, physiology, adaptations to life on land, and ecological interactions with other organisms. Emphasis on the roles of plants in ecosystems and human lives. Key characteristics of major plant lineages in the context of how plants have become such a diverse and successful group of organisms. Students conduct independent research projects on various aspects of plant biology. Laboratory.
Prerequisites: BIO 110, BIO 202, and CHEM 120. MATH 123, 131, 255 or CS 171.
Restrictions: Sophomore standing required.
Usually offered: Annually, spring semester.
Semester credits: 5.

BIO 325 Vertebrate Diversity
Content: The study of vertebrate diversity. Ecological and evolutionary processes that distinguish, promote, and maintain patterns of form, function, and behavior of fish, amphibians, reptiles, birds, and mammals. Lecture, discussion, laboratory; field trips to explore local patterns of diversity in natural settings. May be taught as part of the East Africa Biology-focused overseas program.
Prerequisites: BIO 110, BIO 201, and BIO 202. MATH 115 (or equivalent) or CS 171.
Restrictions: Sophomore standing required.
Usually offered: Every third year, fall semester.
Semester credits: 5.

BIO 335 Ecology
Content: Interactions between organisms and their physical and biological environment. Ecology of populations, communities, and ecosystems, theoretical and empirical approaches. Through reading original literature and designing their own studies, students learn to conduct ecological studies and interpret results. Applications of ecological principles to conservation issues and other environmental problems. Lecture and laboratory; weekend field trip.
Prerequisites: BIO 110, BIO 201, and BIO 202. MATH 123, MATH 131, MATH 255, or CS 171. CHEM 120.
Restrictions: Sophomore standing required.
Usually offered: Annually, spring semester.
Semester credits: 5.

BIO 352 Animal Behavior
Content: Animal behavior, from insects to marine mammals. How and why animals behave as they do. Focus on the adaptiveness of animal behavior using a strong ecological and evolutionary theme. Methods and results associated with animal behavior studies. Lecture, readings in original literature, laboratory, field trips.
Prerequisites: BIO 110, BIO 201, BIO 202. MATH 123, MATH 131, MATH 255, or CS 171. CHEM 120.
Restrictions: Sophomore standing required.
Usually offered: Annually, spring semester.
Semester credits: 5.

BIO 361 Cell Biology
Content: Application of the techniques of biochemistry, microscopy, genetics, and molecular biology to the study of cell structure, function, and physiology. Membrane structure and function, signal transduction, protein and organelle traffic within cells, cell growth, division, and death. Lecture and laboratory.
Prerequisites: BIO 110, BIO 202, CHEM 120.
Restrictions: Sophomore standing required.
Usually offered: Annually, fall semester.
Semester credits: 5.

BIO 369 Developmental Biology
Content: Multidisciplinary study of the process by which multicellular organisms develop from a single fertilized egg. Fertilization, cleavage, gastrulation, early morphogenesis, and organogenesis studied with an emphasis on the genetic, molecular, and evolutionary mechanisms underlying development. Discussion of current research literature illustrating the questions, experimental approaches, and new insights in the study of organismal development. Lecture and laboratory. Laboratory focuses on genetic control of development in the nematode C. elegans.
Prerequisites: BIO 110, BIO 202.
Restrictions: Sophomore standing required.
Usually offered: Every third year, spring semester.
Semester credits: 5.

BIO 370 Disease Ecology
Content: The ecology and evolution of disease in human, plants, and animal systems. Topics will include causes of disease emergence; host-pathogen interactions and co-evolution; interactions between disease and community diversity; and anthropogenic effects on disease, among others. We will use case studies, mathematical theory, and examples from the primary literature to understand the causes and consequences of host-pathogen interactions for populations, communities, and ecosystems. Intended for biology, biochemistry and molecular biology, and environmental studies majors.
Prerequisites: BIO 110, BIO 201, BIO 202. CHEM 120. MATH 123, 131, or 255.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years, fall semester.
Semester credits: 4.

BIO 375 Physiology
Prerequisites: BIO 110, BIO 202. MATH 123, 131, CS 171, or PHYS 141 recommended.
Corequisites: BIO 375L.
Restrictions: Sophomore standing required.
Usually offered: Annually, fall semester.
Semester credits: 5.

BIO 380 Behavioral Genetics
Content: Study of the genetic control of behavior. Familiarization with strategies and techniques used by researchers in this field from information derived from different animal model systems, including humans. Exploration of genetic contribution to social behavior, drug addiction, circadian rhythms, learning and memory, and others. Lecture and lab.
Prerequisites: BIO 110, BIO 202, and CHEM 120. MATH 123, 131, 255, or CS 171. BIO 252, 311, 320, or 361 recommended.
Restrictions: Sophomore standing required.
Usually offered: Annually, fall semester.
Semester credits: 5.
BIO 390 Evolution
Content: Study of the mechanisms responsible for evolutionary change and of their results. History of evolutionary thought, evolution of single-gene and quantitative genetic traits, speciation, and molecular evolution. Role of evolutionary ideas in issues such as species conservation, medicine, science-religion conflicts. Lecture only.
Prerequisites: BIO 110, BIO 201, and BIO 202. MATH 123, MATH 131, MATH 255, or CS 171. CHEM 120.
Restrictions: Sophomore standing required.
Usually offered: Annually, fall and spring semester.
Semester credits: 4.

BIO 393 Biogeography of Australia
Content: Field-centered study of patterns of species diversity in the context of their geological and evolutionary history. The focus will include terrestrial and marine organisms spanning many regions on the Australian continent and Tasmania. Experts on geological history, ecological regions, and particularly interesting lineages will guest lecture.
Prerequisites: BIO 110, BIO 201, and BIO 202.
Restrictions: Acceptance to Australia Biology Focus Overseas Program.
Usually offered: Every third year, spring semester.
Semester credits: 4.

BIO 395 Biology Seminar
Content: Selected topics in biology. Students will have the opportunity to hear research seminars from outside scientists. Students enrolled in the course will develop and present a research seminar of their own. All students taking this course for credit will be required to attend all seminar presentations, both by outside speakers and by their peers, and to participate in the question-and-answer session after the seminar.
Prerequisites: None.
Restrictions: Junior standing required.
Usually offered: Annually, fall semester.
Semester credits: 1.

BIO 407 Venom Biology
Content: Integrative analyses of venoms of Australian animals including field collection, venom collection (by experts, not students), molecular and biochemical analyses of venom components, and assays of activity. Expert Australian venom biologists will guest lecture.
Prerequisites: BIO 110, BIO 201, and BIO 202.
Restrictions: Acceptance to Australia Biology Focus overseas program.
Usually offered: Every third year, spring semester.
Semester credits: 5.

BIO 408 Phylogenetic Biology and Molecular Evolution
Content: Advanced study of theory and methods of reconstructing hypotheses of evolutionary history. Modern phylogenetics relies heavily on models of molecular evolution, thus the course includes a foundation of molecular evolutionary theory. We discuss applications of phylogenies including analyses of gene family evolution, the emergence of infectious disease, biogeography, and coevolution. The lab centers on computational analyses.
Prerequisites: BIO 110, BIO 201, and BIO 202. BIO 390, and either MATH 131, MATH 255, or CS 171, are recommended.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years, spring semester.
Semester credits: 5.

BIO 422 Neurobiology
Content: The biology of the nervous systems of vertebrates and invertebrates, with emphasis on cellular and molecular approaches. Electrical signaling in excitable cells, the physiology and biochemistry of synaptic transmission, neuropharmacology. The biological bases of learning, memory, and some neurological disorders. Sensory systems and neuronal development. Laboratory focus on student-designed projects. Lecture and laboratory.
Prerequisites: BIO 110 and BIO 202 or BIO 361. CHEM 120. PHYS 142 recommended.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years, spring semester.
Semester credits: 5.

BIO 490 Special Topics in Biology
Content: Advanced study of current issues in biology, as determined by student and/or faculty interest. May extend existing areas of the curriculum or explore new subjects. Offering contingent on student interest and faculty availability.
Prerequisites: BIO 110, BIO 201, and BIO 202, and other courses determined by the instructor.
Restrictions: Sophomore standing required.
Usually offered: Alternate Years, fall and spring semester.
Semester credits: 4-5.

BIO 495 Biology Senior Thesis
Content: Yearlong field or laboratory research project designed and executed by a student with guidance from two faculty mentors. A deferred grade will be issued for the first semester of the yearlong series. When the full sequence is completed, the given grade applies to both semesters.
Prerequisites: None.
Restrictions: Senior standing required. GPA of 3.500 in major and overall. Approval of research proposal by department and two supervising faculty members.
Usually offered: Annually, fall and spring semester.
Semester credits: 3.

BIO 499 Independent Study
Content: Participation in a faculty-supervised research or individual study project at Lewis Clark or another research institution. Requires approval of research proposal and a written report. Further information available on biology department website. May be repeated for credit.
Prerequisites: None.
Restrictions: Sophomore standing and consent required.
Usually offered: Annually, fall and spring semester.
Semester credits: 2-4.