

# BIOLOGY

**Chair:** Kenneth Clifton

**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, BIO 107 Field Paleontology of Oregon, 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](http://oregonstateparks.org/park_144.php)) offer convenient sites for field studies.

## The Major Program

The biology curriculum at Lewis & Clark is built around a core of three investigative courses, each of which offers an opportunity for students to learn in depth about one important way in which biologists study living organisms. These three courses focus on ecology and environmental science, genetics and evolutionary biology, and cellular and molecular biology. By delving in depth into particular subdisciplines of biology, students can 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 43 semester credits in biology, plus courses in chemistry and mathematics, distributed as follows:

- BIO 141 Investigations in Ecology and Environmental Science
- BIO 151 Investigations in Genetics and Evolutionary Biology
- BIO 200 Investigations in Cell and Molecular Biology
- 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, at least four of which must be at the 300 or 400 level, 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. Majors are strongly

encouraged to take additional courses in chemistry, mathematics, computer science, and physics.

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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 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 on graduation.

## Faculty

Kellar Autumn. Professor of biology. Physiology, biomechanics, evolution of animal locomotion. PhD 1995 University of California at Berkeley. BA 1988 University of California at Santa Cruz.

Paulette F. Bierzychudek. William Swindells Sr. Professor of Natural Sciences. Evolution, ecology, conservation biology, especially of plants and insects. PhD 1981 Cornell University. BS, BA 1974 University of Washington.

Greta J. Binford. Associate professor of biology, director of the Biochemistry and Molecular Biology Program (fall). Invertebrate zoology, biodiversity, evolution of spider venoms. PhD 2000 University of Arizona. MS 1993 University of Utah. BA 1990 Miami University.

Bianca Breland. Visiting assistant professor of biology. Evolutionary biology, plant biology. PhD 2008, University of Colorado. BA 1995 University of Virginia.

Kenneth E. Clifton. Professor of biology, chair of the Department of Biology. Animal behavior, marine biology, ecology of coral reefs. PhD 1988 University of California at Santa Barbara. BA 1981 University of California at San Diego.

Greg J. Hermann. Professor of biology. Developmental genetics and cell biology. PhD 1998 University of Utah. BS 1992 Gonzaga University.

Deborah E. Lycan. Professor of biology. Molecular biology, cell biology, ribosome biogenesis in eukaryotic cells, yeast genetics. PhD 1983 University of Colorado. BA 1975 University of California at San Diego.

Wendy McLennan. Instructor in biology, biology laboratory stockroom coordinator. AB 1978 University of California at Berkeley.

Margaret Rowan Metz. Assistant professor of biology. Plant community ecology, tropical ecology, disease ecology. PhD 2007 University of California at Davis. AB 1998 Princeton University.

Sharon E. Torigoe. Assistant professor of biology. Molecular biology, biochemistry, gene expression regulation. PhD 2013 University of California, San Diego. BA 2007 Scripps College.

Norma Velázquez Ulloa. Assistant professor of biology. Behavioral genetics, neuroscience, developmental biology, neurophysiology,

cell biology. PhD 2009 University of California at San Diego. BS 2002 Universidad Nacional Autónoma de México.

Family Weissman. Associate professor of biology, co-director of the Neuroscience Program. Neurobiology. PhD 2004 Columbia University. BA 1992 Pomona College.

Pamela Zobel-Thropp. Visiting assistant professor of biology. Biochemistry, molecular biology, transcriptomics, proteomics, bioinformatics. PhD 2000 University of California, Los Angeles. BA 1993 California State University, Long Beach.

## Courses

### BIO 100 Perspectives in Biology

Faculty: Biology Faculty

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 107 Field Paleontology of Oregon

Faculty: Biology Faculty

Content: Survey of fossil forms of organisms with emphasis on animals and evaluation of the diversity of known taxa. Introduction to field paleontological methods and procedures with a focus on the study of the local fauna over geologic time. Lecture, laboratory, and field trips (including required weekend field trips). May not be applied toward the biology major.

Prerequisites: None.

Usually offered: Annually, summer only.

Semester credits: 4.

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

Faculty: Clifton, Loening, Safran, Tufte

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**

Faculty: Biology Faculty

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, and Ecuador 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 141 Investigations in Ecology and Environmental Science**

Faculty: Bierzychudek, Clifton, Metz

Content: An introduction to principles underlying the distribution and abundance of species. Examination of how these principles can inform understanding of issues like overpopulation, climate change, invasive species, pollution, species extinction. Introduction to the methods of scientific investigation through laboratory and field studies that describe ecological phenomena and test hypotheses. Lecture and laboratory. Note: This course is part of the Department of Biology's core curriculum and is intended for biology majors, potential biology majors, and environmental studies majors. The curriculum is challenging and requires a significant time commitment. Therefore, nonmajors are encouraged to fulfill their general education requirements by enrolling in one of the perspectives courses in the natural sciences.

Prerequisites: QR 101.

Restrictions: Open to freshmen and sophomores. Juniors and seniors require departmental consent.

Usually offered: Annually, fall semester.

Semester credits: 5.

**BIO 151 Investigations in Genetics and Evolutionary Biology**

Faculty: Autumn, Binford, Weissman

Content: For majors. Introduction to the fundamental principles of Mendelian genetics, population genetics, and evolution. Principles of genetic analysis in eukaryotes, including introduction to gene function, mutations, and the origin of variability in populations. Overview of evolutionary processes. Laboratory focus on genetic projects. Lecture and laboratory.

Prerequisites: QR 101.

Restrictions: Open to freshmen and sophomores. Juniors and seniors require departmental consent.

Usually offered: Annually, spring semester.

Semester credits: 5.

**BIO 200 Investigations in Cell and Molecular Biology**

Faculty: Hermann, Lycan, Velázquez Ulloa

Content: Introduction to the biochemistry and molecular biology of cells. Structure and function of biomolecules. Introduction to metabolism and photosynthesis in the context of the cell structures in which these processes occur. Introduction to gene expression and protein localization in the context of genetically modified foods and HIV infection. Project-based laboratories on enzyme kinetics, molecular cloning, and cell structure introduce students to experimental design and data analysis in these areas. This course is intended for sophomore-level students who have completed BIO 151 and CHEM 120.

Prerequisites: BIO 151 (may be taken concurrently). CHEM 120 (may be taken concurrently).

Corequisites: BIO 200L.

Usually offered: Annually, spring semester.

Semester credits: 5.

**BIO 211 Land Vertebrates**

Faculty: Clifton

Content: Terrestrial vertebrate diversity. Ecological and evolutionary processes that promote and maintain patterns of form, function, and behavior of birds, mammals, reptiles, and amphibians. Lecture, discussion, laboratory; field trips to explore local patterns of diversity in natural settings. Usually taught as part of the East Africa Biology-focused overseas program.

Prerequisites: BIO 141 and BIO 151. MATH 115 (or equivalent) or CS-171.

Restrictions: Sophomore standing required.

Usually offered: Every third year, fall semester.

Semester credits: 5.

**BIO 212 Invertebrate Zoology**

Faculty: Binford

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 141 and BIO 151.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years, fall semester.

Semester credits: 5.

**BIO 221 Marine Biology**

Faculty: Clifton

Content: Physical, chemical, and biological processes that promote and maintain marine biodiversity. 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. Lecture, discussion, laboratory; field trips to coastal habitats.

Prerequisites: BIO 141 and BIO 151. MATH 115 (or equivalent) or CS-171.

Restrictions: Sophomore standing required.

Usually offered: Every third year, fall semester.

Semester credits: 5.

**BIO 223 Plant Biology**

Faculty: Metz

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; two weekend field trips.

Prerequisites: BIO 141 and BIO 151.

Restrictions: Sophomore standing required.

Usually offered: Annually, spring semester.

Semester credits: 5.

**BIO 244 Practicum**

Faculty: Biology Faculty

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: 2.

**BIO 252 Introduction to Neuroscience**

Faculty: Biology and Psychology Faculty

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 151 and PSY 100, or one of these and permission of instructor.

Restrictions: Sophomore standing required.

Usually offered: Annually, fall semester.

Semester credits: 4.

**BIO 311 Molecular Biology**

Faculty: Lycan

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 151. BIO 200. CHEM 120.

Corequisites: BIO-312.

Restrictions: Sophomore standing required.

Usually offered: Annually, fall semester.

Semester credits: 4.

**BIO 312 Molecular Biology Lab**

Faculty: Lycan

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 151. BIO 200. CHEM 120.

Corequisites: BIO-311.

Restrictions: Sophomore standing required.

Usually offered: Annually, fall semester.

Semester credits: 2.

**BIO 320 Human Genes and Disease**

Faculty: Lycan

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 151. BIO 200.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years, spring semester.

Semester credits: 4.

**BIO 335 Ecology**

Faculty: Bierzychudek

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 141, BIO 151, and BIO 200. MATH 123, MATH 131, MATH 255, or CS 171. CHEM 120.

Restrictions: Sophomore standing required.

Usually offered: Annually, spring semester.

Semester credits: 5.

**BIO 337 Environmental Physiology**

Faculty: Autumn

Content: How major environmental parameters such as respiratory gases, pressure, temperature, and radiation have influenced short-term (acclimatization) and long-term (evolutionary) alterations in the physiology of animals. Lecture only.

Prerequisites: BIO 141, BIO 151, BIO 200, CHEM 120.

Corequisites: BIO 338.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years.

Semester credits: 4.

**BIO 338 Environmental Physiology Lab**

Faculty: Biology Faculty

Content: Introduction to experimental methods in environmental physiology and the scientific process. Students work on open-ended experiments using modern transducers and computer data acquisition, develop strong science writing skills by producing two short scientific papers, and present results of an independent project at an in-class symposium.

Prerequisites: BIO 141, BIO 151, and BIO 200. CHEM 120.

Corequisites: BIO-337.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years, spring semester.

Semester credits: 1.

**BIO 352 Animal Behavior**

Faculty: Clifton

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 141. BIO 151. BIO 200. 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**

Faculty: Hermann

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 151. BIO 200. CHEM 120.

Restrictions: Sophomore standing required.

Usually offered: Annually, fall semester.

Semester credits: 5.

**BIO 369 Developmental Biology**

Faculty: Hermann

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 151. BIO 200.

Restrictions: Sophomore standing required.

Usually offered: Every third year, spring semester.

Semester credits: 5.

**BIO 370 Disease Ecology**

Faculty: Metz

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 141, BIO 151, BIO 200, CHEM 120. MATH 123, 131, or 255.

Restrictions: Sophomore standing required.

Usually offered: Alternate Years, fall semester.

Semester credits: 4.

**BIO 375 Comparative Physiology**

Faculty: Autumn

Content: How different kinds of animals work and why they have evolved to work the way they do. Body size, metabolism, muscle, respiration, cardiovascular function, acid-base balance, temperature, osmoregulation. Common physiological principles that transcend differences in evolutionary history. Physiological adaptations to environmental challenges. Constraints on physiological evolution. Emphasis on recent experimental discoveries and unanswered questions. Intended for biology, biochemistry, and environmental studies majors. Lecture and laboratory.

Prerequisites: BIO 151. BIO 200. MATH 131 or 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**

Faculty: Velázquez Ulloa

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 151, BIO 200, 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**

Faculty: Biology Faculty

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 141, BIO 151, and BIO 200. 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**

Faculty: Binford

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 141, 151, 200.

Restrictions: Acceptance to Australia Biology Focus Overseas Program.

Usually offered: Every third year, spring semester.

Semester credits: 4.



**BIO 395 Biology Seminar**

Faculty: Biology Faculty

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**

Faculty: Binford

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 141, 151, 200.

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**

Faculty: Binford

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 151 and BIO 200. 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**

Faculty: Weissman

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 151 and BIO 200 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**

Faculty: Biology Faculty

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 141, BIO 151, BIO 200, 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**

Faculty: Biology Faculty

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**

Faculty: Biology Faculty

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.