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# BIOLOGY

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## About the Department

The Biology Department offers a breadth of courses in modern biology for science majors and courses on contemporary topics in biology for non-majors. Science education for non-majors is provided through a number of courses that meet first-year seminar, Natural Scientific Approaches, and Connections core requirements. The curriculum for majors covers modern biology from molecules and cells through organisms, populations, and ecosystems, and emphasizes the conceptual, historical, and technical progression of biological science. Specialization in specific areas of biology is made possible by offering a variety of advanced elective courses. The Biology major can be used as preparation for graduate school or professional careers in technical fields, health sciences, and education.

The Biology Department promotes connections between faculty and students through faculty-taught laboratories and a highly organized student/faculty research program. The department has well-equipped laboratories for faculty-directed student research in areas such as cell and molecular biology, physiology, microbiology, ecology, and evolutionary biology. A unique program for our undergraduates includes instruction in the techniques of electron and confocal microscopy and their application to biological problems. For marine and other animal studies, the department maintains a cooperative agreement with Pt. Defiance Zoo and Aquarium. The James R. Slater Museum of Natural History serves not only the students, faculty, and staff at the University of Puget Sound but also the entire Northwest region as a resource for teaching and research.

The curriculum offered in the Biology Department enables students to:

1. Acquire introductory and in-depth knowledge in the field of biology through classroom and laboratory exercises and experiments;
2. Develop intellectually through the practice of the following skills:
  - a. Learning from oral presentations and reading;
  - b. Communicating clearly and well both orally and in writing;
  - c. Locating and analyzing scientific literature;
  - d. Analyzing and solving problems;
  - e. Engaging in scientific observation and experimentation;
  - f. Engaging in quantitative analysis, graphing of data and the use of statistics in data evaluation;
3. Work comfortably, safely, and in an environmentally responsible manner with an extensive array of techniques and instrumentation used in biological research;
4. Collect, interpret, and present scientific data in written reports;
5. Understand the relevance of biology to contemporary issues and problems in society;
6. Acquire a broad background in biology to provide a basis for sustained professional development.

## General Requirements for the Major or Minor

General university degree requirements stipulate that 1) at least four units of the major or three units of the minor be taken in residence at Puget Sound; 2) students earn at least a cumulative GPA of 2.0 in courses taken

for the major or the minor; and 3) all courses taken for a major or minor must be taken for graded credit. Any exceptions to these stipulations are indicated in the major and minor degree requirements listed below.

## Requirements for the Major

The Biology and Molecular and Cellular Biology degrees offered at Puget Sound are based on similar principles. Both degrees are rooted in the fundamentals of living systems, their relationship to each other, their evolution, structure and function. Both degrees further emphasize the use of experimental approaches and the development of scientific writing skills. The Biology degree offers a broad approach to the living world stressing both molecular-cellular aspects and organismal-ecological aspects of life. In contrast, the Molecular and Cellular Biology degree emphasizes the molecular and genetic basis of organisms and the biochemical adaptations and pathways that unify and distinguish them. In both degrees, students develop interdisciplinary skills in biology and chemistry.

## Requirements for the Major in Biology (BS)

Completion of a minimum of 15 units of Biology and supporting courses to include:

1. Biology core courses: BIOL 111, 112, 211, 212, 213 and one unit from the following: 332 or 334;
2. Biology electives: Three additional units in biology courses numbered at 312 or above, excluding 398. GEOL 306 (Fossil Record) may count as one of the three units. CHEM 461 may count as one of the three units. One unit may count toward the major from research or independent study courses: BIOL 390, 392, 490, 491, 495, 496;
3. Three units in chemistry: CHEM 110, 120, 250; OR 115, 230, 250;
4. One unit of mathematics: MATH 180 or 181;
5. Two additional units from the following: One unit from BIOL 312 or higher; CHEM 251 or higher; CSCI 141 or higher, EXSC 222; GEOL 101 or higher; MATH 110 or higher; NRSC 201, 350; PHYS 111 or higher. MATH110 and CHEM105 can count towards this requirement if, and only if, the course was taken prior to taking courses in the respective subjects with higher course numbers.

## Requirements for the Major in Molecular and Cellular Biology (BS)

Completion of a minimum of 16 units of Biology and supporting courses to include:

1. Four units in Biology: BIOL 111, 212, 213, 404
2. General Chemistry: CHEM 110, 120, 231, or 115, 230
3. Organic Chemistry: CHEM 250, 251
4. Biochemistry: CHEM 460, 461
5. Two units of Mathematics: Any two of MATH 180, 181, and 260. MATH 160 may substitute for MATH 260 if and only if BIOL 211 or BIOL 231 is also taken
6. Two units of analytical science from the following: BIOL 211 or 231; CHEM 231; PHYS 111/112 or 121/122; MATH 110 and higher; CSCI 141 and higher
7. Two additional units in Biology, one of which must be at the 300 or 400 level (excluding 398), and which can include up to one unit of research credit (BIOL 390, 490, or 491). Students with an interest in evolutionary, environmental, or ecological applications of molecular biology should strongly consider BIOL 112 and 360 as their electives. Students may not use BIOL 361 to satisfy this requirement.

## Requirements for the Minor in Biology

Completion of five units of Biology to include BIOL 111 and 112, a minimum of one course from the following group (BIOL 211, 212, 213) and two elective units (BIOL 211 or higher; GEOL 306 may count as one of the two units). BIOL 398 does not count towards the Biology Minor.

### Notes for the major and minor

- The following courses do not satisfy major or minor requirements: BIOL 101, 102, 201, 205, 398, 498, or 499; INTN 497.
- Students majoring in Molecular and Cellular Biology may not also major or minor in Biology, Chemistry, or Biochemistry. There is no minor in Molecular and Cellular Biology.
- Students should pay careful attention to course prerequisites as they affect course sequencing.
- Majors are encouraged to participate in the undergraduate research program within the department. Courses in the undergraduate research program include Biology Colloquium (201), Directed Research (290/390/490), Introduction to Biological Research (392), Science and Mathematics Seminar Series (398), and Senior Thesis (491). Students may begin doing research with faculty members at any time in their career. Students who wish to do a senior thesis project can enroll in Biology Colloquium (201), Introduction to Biological Research (392), and either one unit of Senior Thesis (491) or one unit of Senior Directed Research (490) and one of Senior Thesis (491). Students may count one unit of research (390, 490, or 491) as one of the advanced Biology electives required for the degree. Students doing research must consult with and gain approval from a Biology faculty research adviser, and must submit a research proposal.
- Students are encouraged to select electives and other courses beyond the major requirements in consultation with their academic advisor and/or the Health Professions advisor to personalize their academic experience to match their interests and, if relevant, to prepare them for graduate or professional school programs.
- Majors who wish to obtain secondary-level teaching certification may do so by satisfying the MAT requirements of the School of Education. Details and requirements may be obtained from the School of Education.
- All courses required for the majors or minor must be taken on a graded basis. The credit/no credit grading option is not recommended for any student planning to enter graduate or professional school. Biology activity classes (BIOL 201, 205, 398) cannot be applied towards the Biology majors or minor.
- To be eligible to graduate with departmental honors, a student must maintain a GPA in accordance with university regulations for such distinction and must complete an independent research project.
- Coursework completed more than ten years prior to completion of degree requirements may not be counted towards fulfilling degree requirements for the majors or the minor.
- At least two of the Biology electives and one of the Molecular and Cellular Biology electives must be completed on the Puget Sound campus.
- For Biology majors, at least two of the Biology elective courses (BIOL 312 and above) must have a lab component. One unit of Junior or Senior-level Research (BIOL 390, 490, or 491) can be used to fulfill one of these lab course requirements.

## Course Offerings

Unless otherwise specified, each course carries 1 unit of credit and is offered at least once each academic year. Please see "Frequency of Course Offerings" on page 20.

**Seminars in Scholarly Inquiry.** See *Seminars in Scholarly Inquiry in the Core Curriculum* section of this Bulletin for course descriptions.

- SSI2 103 Understanding Brain Function**
- SSI1/SSI2 110 Examining Dogs Through the Lens of Science**
- SSI2 114 Humans, Nature, and the Environment**
- SSI1 165 Never Really Alone: Symbioses and Parasitism Around and Within Us**
- SSI1 169 Cancer in Context**

**Other courses offered by Biology Department faculty.** See *Connections in the Core Curriculum* section of this Bulletin for course descriptions.

### **CONN 303 Art-Science: Inquiry into the Intersection of Art, Science, and Technology**

Satisfies the Connections core requirement.

### **CONN 307 Hooch: The Natural and Social Science of Liquor**

Satisfies the Connections core requirement.

### **CONN 313 Biomimicry and Bioart**

Satisfies the Connections core requirement.

### **ENVR 335 Thinking About Biodiversity**

Satisfies the Connections core requirement.

## Biology (BIOL)

**101 Introduction to Biology** This course introduces the organizing principles of biology through a study of selected cellular, organismal, and ecological systems. Relevant topics are used to illustrate fundamental concepts. The course takes a thematic approach in which the chosen examples relate to a particular topic. The use of a theme topic highlights the interconnection of the various fields of biology and illustrates the complexity of relevant problems. Laboratory is required. *Credit will not be granted to students who have received credit for BIOL 102 or 111. Satisfies the Natural Scientific Approaches core requirement. Offered frequently.*

**102 Evolution and Biology of Sex** This course introduces students to important biological concepts and approaches of study, and applies them to questions about sexual reproduction. Topics include: scientific inquiry, evolution, the central dogma of molecular biology, basic genetics and inheritance, development, behavioral ecology, and population growth. The course takes a decidedly comparative approach, utilizing information from many different species, including humans. Laboratory is required. *Credit will not be granted to students who have received credit for BIOL 101 or 111. Satisfies the Natural Scientific Approaches core requirement. Offered frequently.*

**111 Unity of Life: Cells, Molecules, and Systems** A contemporary approach to the major themes of modern biology. Subcellular, cellular, genetic, and physiological aspects of biological systems are explored in the context of the scientific process. Laboratory is required. *Satisfies the Natural Scientific Approaches core requirement. Offered every semester.*

**112 Evolution and the Diversity of Life** This course explores the mechanisms of evolution and the vast diversity of life to which it gave rise. The characteristics that define different groups of organisms, and the evolutionary relationships among these groups are explored. Structure and function relationships are emphasized throughout the course. Laboratory is required. Some labs involve the dissection of plants, animals, and fungi. Some labs may involve the collection and sacrificing of zooplankton and insects as well as the handling of plant and animal parts obtained from a supermarket. *Satisfies the Natural Scientific Approaches core requirement. Offered every semester.*

**201 Biology Colloquium** 0.25 activity units. This course introduces Biology majors to the professional activities of departmental faculty and staff. It includes a series of presentations by Biology faculty relating their interests in both teaching and research, with a description of current research projects. It also includes orientation to the research support facilities provided by the Biology Department. *Prerequisite: Two semesters of Biology credit. Pass/Fail Required. Offered occasionally.*

**205 Natural History Museum Docent** 0.25 activity units. This course is designed to provide a general overview of natural history museum practices that support the main functions of these institutions: research and education. Natural history museums are invaluable archives of Earth's biodiversity and were the primary locus for biological research in the 18th and 19th centuries. The vast collections of specimens in natural history museums provide a temporal and geographic record of life unmatched by written or illustrated accounts. They document variation - the foundation of evolution - in time and space and allow biologists to make comparisons that are difficult or impossible to observe in the field. Students learn about the resources housed in the Slater Museum of Natural History and be trained as Docents, learning and developing stories, providing tours, staffing open hours and Nights at the Museum and teaching museum curricula in K-12 schools. *May be repeated for credit. Pass/Fail Required. Offered occasionally.*

**211 General Ecology** An introduction to the interactions of individuals in a population, populations in a community, and communities in ecosystems. Laboratories are designed to illustrate ecological principles and give experience in approaches and techniques of ecology. Experimental design, quantitative data analysis, and statistics are emphasized throughout the course. *Prerequisite: BIOL 112 or equivalent. Offered every semester.*

**212 Cell Biology** The structure, metabolism, and specialized activities of eukaryotic cells are the major lecture topics. Complementary laboratories focus on microscopy and biochemical techniques. Data analysis is highly emphasized throughout the course. *Prerequisite: BIOL 111, and CHEM 115 or 120, or permission of instructor. Offered every semester.*

**213 Genetics** This course introduces students to the principles of classical and modern genetics. The laboratory illustrates major concepts in genetics through directed inquiry experiments. *Prerequisite: BIOL 111 or 112, and one additional BIOL or CHEM course with lab (CHEM 110 or higher). Offered every semester.*

**215 Methods in Molecular and Cell Biology** 0.50 units. This course is an introduction to wet lab methods and approaches commonly used in molecular and cell biology. General methodological areas taught include, but are not limited to: calculations and preparation of solutions, UV-visible light spectrophotometry, PCR, preparation and analysis of proteins and nucleic acids by gel electrophoresis and blotting. This lab-based course is centered around a faculty member's area of scholarly interest and expertise, and students learn and practice methods by a project-oriented approach. Experimental results and interpretations stemming from experiments completed by students are communicated through both written lab reports and oral presentations. By engaging with this lab experience, concepts relating to gene function and cellular processes are reinforced, and these molecular-level concepts may also be connected with biological systems at the organism, population, and ecological levels. Students read papers from the primary research literature relating to methods and overall experimental strategies covered throughout the semester. Completing this course increases student preparation for upper division biology courses, in particular those emphasizing lab skill sets in molecular and cell biology. *Prerequisite: BIOL*

*111 or 112, and one additional BIOL or CHEM course with lab (CHEM 110 or higher). Offered occasionally.*

**231 Biostatistics** 0.50 units. This course introduces MCB majors who did not take BIOL 211 (General Ecology) to important statistical concepts, experimental design, and data analysis tools that are covered in BIOL 211. Topics of study include: Introduction to the software R and RStudio, and introduction to basic statistical tests and data analysis and graphing using R and Excel. This course is exempt from the tuition overload policy. *Prerequisite: BIOL 111 or AP credit. Not open to students who have taken BIOL 211. Offered every year.*

**290 Directed Research** Variable credit up to 1.00 unit. This course provides a laboratory/field research experience for sophomores under the direction of a faculty mentor. Students may initiate a project or join a research project in the mentor's lab. Student and mentor fill out a departmental contract. A written research paper and a reflective summary of the research experience must be submitted for a final grade. Students are strongly encouraged to take BIOL 201 before choosing a research project. May be repeated up to 1 unit. *Prerequisite: Permission of the instructor. May be repeated for credit up to 1.00 unit. Cannot be audited. Cannot be taken Credit/No Credit. Offered every semester.*

**310 Special Topics in Biology** In this course, students will gain experience and reasoning skills in the biological sciences by focusing on a specific topic, theme, or sub-area of the discipline. Through classroom discussion, written work, and other forms of assessment, students will evaluate information and learn how the scientific process is applied in the context of the theme covered. Students will also make connections between the biological topic of study and society. *Prerequisite: One 100-level Biology course. Offered occasionally.*

**332 Molecular Biology and Physiology of Plants** A study of growth, nutrition, and metabolism of the higher plants at the organismal, cellular, and molecular levels. Laboratory demonstrates data collection methodology, data analysis, and experimental design in plant physiology. *Prerequisite: BIOL 212 and one year of college chemistry; BIOL 112 recommended. Offered spring semester.*

**334 Comparative Animal Physiology** A study of function at the systems and cellular levels in a variety of animal forms with emphasis on fundamental physiological principles. Physiological adaptation to different habitats is also discussed. Laboratory involves application of various experimental techniques. Lab is required. Some labs require the dissection of earthworms, the use of crab blood, and may require the use of live tissue preparations. *Prerequisite: BIOL 111, 112, 212, one year of college chemistry, and one of the following: BIOL 211, BIOL 231, MATH 160, MATH 260, or permission of the instructor. Offered fall semester.*

**340 Animal Communication** This course examines the production, transmission and reception of animal communication signals in different sensory modalities, including acoustic, visual, chemical, and short-range sensory modes. In addition, the course explores the evolution and function of such signals as mechanisms to transfer information and bias decision making. Throughout the semester, students draw upon theory from ecology, physiology and evolution, as well as the physical sciences and economics. *Prerequisite: BIOL 111 and 112; 211 recommended. Offered occasionally.*

**350 Microbiology** Microbiology is the biology of two of the three Domains of life (the bacteria, the archaea, and the viruses of both) as opposed to eukaryotic organisms. This course explores three aspects of microbiology—diversity, ecology, and interactions with other organisms

(including pathogen/host relationships in medical microbiology and more mutualistic associations such as symbioses). A term paper exploring the natural history of a particular microbe or related topic is required for this course. The laboratory includes basic microbiological techniques, classic experiments, and introduces current paradigm shifts in microbiology, including sociomicrobiology, microbial genomics, quorum sensing, and biofilms. Student teams carry out and write a report on an independent lab project of their own design. Students also read and discuss "cutting edge" journal articles showcasing recent advances in microbiology, and present those papers to their peers. *Prerequisite: BIOL 212, one year of college chemistry, and CHEM 250. Offered every year.*

**360 Evolution** Evolution is fundamental to understanding the big why and how questions in biology. Beginning with the fundamentals of population genetics, this course explores a diverse array of topics such as speciation, mass extinctions, adaptive radiation, molecular evolution, systematics, disease, and conservation biology. *Prerequisite: BIOL 112; 211 and/or 213 recommended. Offered every year.*

**361 Biochemical Pathways and Processes** This course deals with the structure and function of proteins, carbohydrates, fats, and nucleic acids at the cellular and molecular levels. The course emphasizes both the interrelationships among major metabolic pathways, and how modern techniques are applied to study biomolecular structure and function. The course is suitable for students interested in health-related fields as well as those interested in broader applications. There is no laboratory associated with this course. *Prerequisite: BIOL 212, one year of college chemistry, and CHEM 250; BIOL 213 recommended. Offered spring semester.*

**362 Nanobiology** This course offers students an introduction to the field of nanobiology. Nanotechnology is becoming a new frontier in biological explorations and manipulation. Engineering tools and techniques have been used to expand biological research, enrich the medical field, as well as alter food and materials. Fast expanding, nanobiology is becoming a part of the cultural lexicon, with ramifications in both ethical and cultural aspects of everyday life. This course explores these themes, with overviews of methodologies and future technology. *Prerequisite: BIOL 101, 111, or 112 AND CHEM 110 or 115 OR PHYS 111 or 121. Satisfies the Knowledge, Identity, Power graduation requirement. Offered occasionally.*

**363 Biophysics** This course explores the principles of physics applied to living systems. Topics include diffusion, hydrodynamics and the low Reynolds-number world, importance of entropy and free energy, entropic forces, molecular machines, membranes, and nerve impulses. Written and oral scientific communication is emphasized. This course is appropriate for junior or senior undergraduates in the sciences, particularly physics and biology. No specialized knowledge of biology or physics is expected, but a facility with algebraic manipulations and a working knowledge of calculus is needed. *Cross-listed as BIOL/PHYS 363. Prerequisite: Math 180 and Physics 111 or 121; and either BIOL 212 or a 300-level course in Biology or Physics; or permission of the instructor. Offered frequently.*

**364 Marine Invertebrate Zoology** Marine Invertebrate Zoology takes advantage of the rich marine biota of the Salish Sea to introduce students to the principles of animal organization and biodiversity. Emphasis is placed on homology and convergence, diversity and complexity, and is presented in a phylogenetic and ecological context through the study of form and function of living and preserved specimens. In addition to the basics of invertebrate anatomy, development, ecology and evolution, this course includes analysis of evolutionary changes and discus-

sion of the fossil record. The course includes a laboratory component offering hands-on experience working with marine invertebrates from the DNA to the whole organism level. *Prerequisite: BIOL 112; BIOL 111 recommended. Cannot be audited. Offered occasionally.*

**365 Applied Bioinformatics** This course introduces students to the principles and practical applications of bioinformatics in the analysis of genomic data. Students learn how to use bioinformatics software to evaluate and analyze genomic data to answer questions in molecular and evolutionary genetics. *Prerequisite: BIOL 213. Offered occasionally.*

**370 Conservation Biology** This course focuses on biological concepts and techniques fundamental to the science of conservation biology. To understand mechanisms that drive the loss of biological diversity and approaches to address those threats, the course explores a variety of topics including extinction processes, population dynamics, population genetics, habitat fragmentation, invasive species, protected area design, and restoration ecology. The laboratory component involves field work, including a full weekend field trip, and quantitative computer simulations. *Prerequisite: BIOL 211 and Junior or Senior standing. Offered fall semester.*

**374 Mammalian Cell Microanatomy** Mammals are composed of a number of highly integrated physiological systems, the tissues and organs, each with characteristic structure and function. This course combines aspects of histology, cell biology, and physiology to analyze the cells and tissues of mammals. The principal goal of this course is to learn the structure and function of normal mammalian tissues. Key experiments that have produced our understanding of cell structures and function are analyzed. *Prerequisite: BIOL 212 and one year of college chemistry. Offered occasionally.*

**375 Developmental Biology** Contemporary theories on differentiation and descriptive patterns of development with emphasis on animals. The laboratory deals with a variety of invertebrates and vertebrates including some experiments with living materials. Alternative exercises are provided for students who prefer not to work with living animals. *Prerequisite: BIOL 111 and one year of college chemistry; BIOL 213 recommended. Offered occasionally.*

**376 One: Our Symbiotic Planet** This course is designed for juniors and seniors interested in learning more about the diversity, depth, and breadth of associations between organisms. Such associations and their study range from mutualism to parasitism, from viruses to cetaceans, from biochemical to ecological approaches. The first part of the course explores the history and paradigms in the study of symbioses, using specific case studies and journal articles. The second part of the course involves critical analysis of current peer reviewed journal articles by experts in the field, who will "tele-visit" the classroom to discuss their work with students. Finally, there are individual and group projects exploring a student-chosen specific association of particular interest. There is no laboratory associated with this course. *Prerequisite: BIOL 111, 212, and one year of college chemistry, or permission of instructor. BIOL 112 and 213 are recommended. Cannot be audited. Offered occasionally.*

**377 Field Botany** This course is designed to introduce you to identifying plants, help you become familiar with the local plants, understand their systematic relationships, and understand their natural history as part of communities. As such, it is intended to be a hybrid between a plant systematics course, a plant identification course, and a plant natural history/ecology course. The lecture will cover concepts and theory; the lab will be devoted to hands-on identification and species recogni-

tion. Field trips will allow you to practice family and species recognition as well as to see some of the natural history discussed in lecture.

*Prerequisite: BIOL 112 and 211. Offered occasionally.*

**378 Vertebrate Biology** A survey of the major groups of vertebrates with emphasis on evolution, adaptation, morphology, ecology, and behavior. Vertebrates of the varied habitats of the Pacific Northwest are studied in the lab and in the field. Laboratories may involve dissection of vertebrate animals. *Prerequisite: BIOL 112 or equivalent. Offered occasionally.*

**379 Ornithology** This course examines the origin, speciation, diversity, ecology, behavior, and conservation of birds. The laboratory component will include field trips as well as draw from the Slater Museum's extensive bird collection for studies of avian taxonomy, identification, anatomy and physiology. *Prerequisite: BIOL 211. Offered occasionally.*

**390 Junior Directed Research** Variable credit up to 1.00 unit. This course provides a laboratory/field research experience for juniors under the direction of a faculty mentor. Students may initiate a project or join a research project in the mentor's lab. Student and mentor fill out a departmental contract. A written research paper, a reflective summary of the research experience, and an oral or poster presentation must be submitted for a final grade. Students are strongly encouraged to take BIOL 201 before choosing a research project. *May be repeated for credit up to 1.00 unit. Cannot be audited. Cannot be taken Credit/No Credit. Offered every semester.*

**392 Introduction to Biological Research** 0.50 units. The main audience for this course are students interested in a) preparing a research proposal that they want to submit for funding to the University of Puget Sound Summer Research Program, and b) doing full-time research over the summer following the course with a Puget Sound faculty member in the sciences. During the course students will match up with a research advisor, learn techniques on how to write an effective proposal, and become familiar with general research procedures, and aspects of research ethics. Open to second and third year students. This course is exempt from the tuition overload policy. *Prerequisite: Second and third year students. Biology majors: any two of BIOL 211, 212, and 213, though one of these may be concurrent with BIOL 392; MCB majors: BIOL 212 or 213. All others require permission of instructor. May be repeated for credit. Offered spring semester.*

**395 The History, Utility, and Practices of Natural History Museums** 0.50 units. This course is designed to provide a general overview of natural history museum uses and practices. Natural history museums were the primary locus for biological research in the 18th and 19th centuries. They represent invaluable archives of Earth's biodiversity; their vast collections of specimens provide a temporal and geographic record of life unmatched by written or illustrated accounts. They document variation—the foundation of evolution—in time and space and allow biologists to make comparisons that are difficult or impossible to observe in the field. Natural history museums are an incredible resource for researchers with interests in evolution, ecology, zoology, botany and environmental change. They are phenomenal venues for teaching and engaging students ranging from young children to senior citizens. And they are sources of inspiration for scientists and artists. In this course students learn the history of natural history collections, engage in the practices of natural history museums, learn the myriad ways that natural specimens have been used in research, and do an independent project. *Cross-listed as BIOL/ENVR 395. Prerequisite: BIOL 112, 211, or permission of instructor. Offered occasionally.*

**398 Science and Mathematics Seminar Series** 0.25 activity units. This course promotes active and regular attendance at science and mathematics seminars. Students attend a minimum of 12 full-length science or mathematics seminars each semester and write up a summary of each presentation attended. Students are free to meet the minimum seminar requirement according to their interests and class schedule, but are strongly encouraged to attend the Thompson Hall Science and Mathematics Seminar Series to at least partially fulfill the 12 seminar requirement. *May be repeated for credit. Pass/Fail Required. Offered every semester.*

**404 Molecular Biology** Molecular Biology focuses on the structure, organization, and regulation of genetic material at the molecular level. This course emphasizes modern analyses of genomes and transcripts while also introducing students to contemporary techniques used to manipulate gene expression or edit the genome. *Prerequisite: BIOL 212 and 213; one year of college chemistry. Senior standing recommended. Offered every semester.*

**411 Advanced Ecology** This course provides an in-depth examination of major ecological fields, including ecophysiology, island biogeography, community ecology, and ecosystem ecology. Current ecological research is used to introduce major concepts and methods, foster critical thinking and discussion, and to introduce issues of experimental design and analysis and different approaches to ecology. This course enhances skills that are critical for ecologists including written and oral communication skills, quantitative and programming skills. *Prerequisite: BIOL 112 and 211. Offered occasionally.*

**434 Neurobiology** An examination of the biology of nerve cells and nervous systems through lectures and discussion of recent research. Topics include cell biology of the neuron, synaptic interactions and the neural bases of learning and memory, the neural circuitry underlying behavior, and developmental neurobiology. Emphasis is placed on students' oral and written evaluations of scientific literature. *Prerequisite: BIOL 212, one year of college chemistry, junior or senior standing, and permission of the instructor. Offered frequently.*

**441 Cancer Biology** This course examines genetic alterations that contribute to cancer and how they disrupt normal regulation of cell growth. Several specific mechanisms that promote cancer progression are examined in detail, providing a platform for thoughtful consideration of current therapeutic approaches. *Prerequisite: BIOL 212 and 213; one year of college chemistry. Offered occasionally.*

**465 Chemical Biology** This course explores how modern chemical and biochemical strategies are used to interrogate and manipulate biological systems. The course will focus on selected, recent developments in the field as described in review articles and the primary literature. Themes include modifying and expanding the genetic code, screening and selection of chemical and biological libraries, directed evolution and rational design in the production of new protein activities, molecular imaging and probes for spatial and temporal localization of biological activity, modification of biological systems to produce new products or new activities, and design and use of novel molecular effectors of biological systems. In addition to examining the science of chemical biology, the course will also explore the commercialization of chemical biology and the background and influence of key individuals involved in developing this hybrid discipline. The course will emphasize process, with students directly engaging with primary sources, collaboratively analyzing and discussing information obtained from those sources, selecting and investigating topics in chemical biology that interest them, presenting the results of their investigations to their peers, and

reflecting upon the scientific, commercial, and social impacts of modern chemical biology. Cross-listed as BIOL/CHEM 465 *Cross-listed as BIOL/CHEM 465. Prerequisite: CHEM 251 and either BIOL 212 or 213. Instructor permission required. Cannot be audited.*

**472 Animal Behavior** This course provides a survey of key concepts, theories and models in the field of Animal Behavior, integrating behavioral analyses into an explicitly evolutionary framework. Students discuss behaviors important to reproduction, such as selecting mates, and those important to survival, such as finding food and avoiding predators. For each of these contexts, students ask both 'proximate' and 'ultimate' questions. Proximate questions concern the mechanistic causes of behavior, including the genetic, hormonal, neural and environmental influences on the development and expression of behavior. Ultimate questions of behavior concern how behavior is shaped and constrained by ecology and evolutionary history. Students actively discuss modern theory, engage in observational and experimental study, and develop an innovative research proposal. *Prerequisite: BIOL 211. Offered frequently.*

**477 Marine Biology** The marine environment encompasses 99% of the Earth's biosphere and contains an incredible diversity of microbial, algal, and animal life forms. This course examines the biology of these organisms and the abiotic (e.g., salinity, nutrients, water currents and tides) and biotic factors (e.g., competition, predation, symbiosis) that influence their distribution and abundance. Specific topics include primary and secondary production, rocky intertidal biodiversity, estuaries, subtidal communities, coral reefs, pelagic and deep sea communities, impacts of humans on the ocean, and conservation. Lecture periods include discussions of primary literature and student presentations. Laboratory sessions involve field work, laboratory analyses, report writing, and multimedia presentation of project results. *Prerequisite: BIOL 112, and 211. GEOL 105 recommended. Offered fall semester.*

**490 Directed Research** Variable credit up to 1.00 unit. This course provides a laboratory/field research experience for seniors under the direction of a faculty mentor. Students may initiate a project or join a research project in the mentor's lab. Student and mentor fill out a departmental contract. A written research paper, a reflective summary of the research experience, and an oral or poster presentation must be submitted for a final grade. Students are strongly encouraged to take BIOL 201 before choosing a research project. *Prerequisite: Permission of instructor; BIOL 201 recommended. May be repeated for credit up to 2.00 units. Cannot be audited. Cannot be taken Credit/No Credit. Offered every semester.*

**491 Senior Thesis** Variable credit up to 1.00 unit. Students must write a research proposal, carry out the research, write a thesis, and present a public seminar on their research. The projects are done under the supervision of a faculty research advisor. Details and application forms can be obtained from faculty research advisor or department chair. *Prerequisite: Permission of instructor; BIOL 201 recommended. May be repeated for credit up to 1.00 unit. Cannot be taken Credit/No Credit. Offered every semester.*

**495 Independent Study** Variable credit up to 1.00 unit. Independent study is available to those students who wish to continue their learning in an area after completing the regularly offered courses in that area. *May be repeated for credit up to 4.00 units. Cannot be audited. Cannot be taken Credit/No Credit.*

**498 Internship Seminar** Variable credit up to 1.00 unit. This scheduled weekly interdisciplinary seminar provides the context to reflect on concrete experiences at an off-campus internship site and to link these experiences to academic study relating to the political, psychological,

social, economic and intellectual forces that shape our views on work and its meaning. The aim is to integrate study in the liberal arts with issues and themes surrounding the pursuit of a creative, productive, and satisfying professional life. Students receive 1.0 unit of academic credit for the academic work that augments their concurrent internship fieldwork. This course is not applicable to the Upper-Division Graduation Requirement. Only 1.0 unit may be assigned to an individual internship and no more than 2.0 units of internship credit, or internship credit in combination with co-operative education credit, may be applied to an undergraduate degree. *Prerequisite: Junior or senior standing, 2.5 GPA, ability to complete 120 hours at internship site, approval of the CES internship coordinator, and completion of learning agreement. May be repeated for credit up to 2.00 units. Cannot be audited. Cannot be taken Credit/No Credit.*