

# Biology

## MAJORS, MINOR

**PROFESSORS:** Renee Godard, C. Morgan Wilson (chair)

**ASSOCIATE PROFESSOR:** Rebecca Beach

**ASSISTANT PROFESSORS:** Mary Jane Carmichael, Elizabeth Gleim

**LABORATORY TECHNICIAN:** Cheryl Taylor

The biology major seeks to develop in its students a sense of independent inquiry into the processes of life. Core courses in the major provide all students with a solid foundation in the biological sciences (from cells to ecosystems), while upper-level courses and seminars as well as research opportunities give students the chance to focus on specific areas of interest in biology. As well as exploring biological concepts, classes in the biology department promote the development of oral and written communication skills as well as critical thinking. Graduating seniors will have the skills to critique the primary biological literature, utilize biological instrumentation, and design and carry out biological research in several disciplines. Hollins graduates go on to graduate school, medical school, veterinary school, or other advanced training in allied health professions. Other graduates pursue a variety of careers in the biological sciences, becoming research assistants, environmental consultants, and teachers at both the elementary and secondary levels. Biology majors also occupy various technical positions in private firms and governmental agencies.

### REQUIREMENTS FOR A MAJOR IN BIOLOGY (B.A.):

8 courses and associated laboratories, if applicable; one semester of sophomore seminar, one semester of senior capstone, and allied courses (52-70 credits)

#### REQUIRED COURSES IN BIOLOGY:

- Three core courses in biology and accompanying laboratories:  
BIOL 207: Ecology and BIOL 207L (4, 2)  
BIOL 220: Human Physiology and BIOL 220L (4, 2)  
BIOL 236: Molecular and Cell Biology and BIOL 236L (4, 2)
- BIOL 200: Sophomore Biology Seminar (2)
- Five elective courses in biology at or above the 200 level (including labs, if applicable). No more than one elective course may come from the following: BIOL/CHEM 351, 352, or BIOL/PSY 317. A student may substitute one semester of BIOL 390, BIOL 391, or BIOL 480 for one of the elective courses. (A student may petition the department to include one course at the 100 level among the five elective courses, if the course is taken before the student decides to major in biology.)
- BIOL 399: Biological Internship (any term)
- BIOL 471: Senior Capstone (2)

#### REQUIRED ALLIED COURSES:

- CHEM 101 and CHEM 102: General Chemistry (including laboratories) (4, 2) (4, 2) or CHEM 105: Principles of Chemistry (including laboratory) (4, 2)
- One course in mathematics or statistics (140 or above) or PSY 208: Research Statistics (4)

#### FOR STUDENTS INTERESTED IN TEACHING IN SECONDARY SCHOOLS:

- CHEM 221 and 221L: Organic Chemistry I (4, 2)
- PHYS 151 and 151L: Physical Principles I (4, 2)
- ES/PHYS 241: Geology and Earth History (4)
- STAT 140: Introduction to Statistics or STAT 251: Statistics Methods I (4)

For students interested in medical school, veterinary school, or graduate programs in the health sciences or biology, the B.S. degree includes the necessary prerequisite allied courses required of most programs.

### REQUIREMENTS FOR A MAJOR IN BIOLOGY (B.S.):

8 courses and associated laboratories, if applicable; one semester of sophomore seminar, one semester of senior capstone, and allied courses (76-94 credits)

#### REQUIRED COURSES IN BIOLOGY:

- Three core courses in biology and accompanying laboratories:  
BIOL 207: Ecology and BIOL 207L (4, 2)  
BIOL 220: Human Physiology and BIOL 220L (4, 2)

- BIOL 236: Molecular and Cell Biology and BIOL 236L (4, 2)
- BIOL 200: Sophomore Biology Seminar (2)
- Five upper-level elective courses in biology three of which must be laboratory courses at the 300 level. No more than one elective course may come from the following: BIOL/CHEM 351, 352, or BIOL/PSY 317. Students pursuing a B.S. degree are encouraged to conduct independent research [either BIOL 391 or BIOL 480(4)]
- BIOL 399: Biological Internship (any term)
- BIOL 471: Senior Capstone (2)

**REQUIRED ALLIED COURSES:**

- CHEM 101 and CHEM 102: General Chemistry (including laboratories) (4, 2) (4, 2) or CHEM 105: Principles of Chemistry (including laboratory) (4, 2)
- One course in mathematics/statistics from the following: MATH 152, MATH 241, STAT 140, STAT 251, or PSY 208(4–6). Note that Math 140 is the pre-requisite course for PHYS 151/151L below.

**And one of the following:**

- Two additional chemistry courses (with labs), at or above the 200 level (8–12) **AND** PHYS 151/151L and PHYS 152/152L or PHYS 201/201L and PHYS 202/202L **OR**
- Four additional chemistry courses (with labs), at or above the 200 level (24)

**REQUIREMENTS FOR A MINOR IN BIOLOGY:**

Five courses and associated laboratories, if applicable (20-24 credits)

- Two core courses in biology and accompanying laboratories chosen from the following:  
BIOL 207: Ecology and BIOL 207L (4, 2)  
BIOL 220: Human Physiology and BIOL 220L (4, 2)  
BIOL 236: Molecular and Cell Biology and BIOL 236L (4, 2)
- Three elective courses in biology at or above the 200 level (including laboratories, if applicable)

**COURSES IN BIOLOGY:****BIOL 117: ENVIRONMENTAL SCIENCE (4)****Du Bray**

In this lecture/laboratory course students explore how organisms, communities, and ecosystems function under natural conditions, as well as how they function under human influence. We will cover a variety of current environmental concerns in both the classroom and laboratory, including the patterns of human population growth, the extinction crisis, global warming, acid rain, water pollution, solid waste management, sustainable agriculture, and renewable energy. Also listed as ES 117. Not intended for students majoring in biology. Open to first-year students. No prerequisite. Offered both terms. (SCI)

**BIOL 130: BIOLOGICAL SELF-DEFENSE (4)****Department**

This lecture/laboratory course will explore how the human immune system protects us from diseases and the pathogens that are constantly trying to breach this system. The outcome of this delicate balance dictates the state of human health. Topics covered will include infectious diseases, cancer, and other diseases of public health interest. Laboratory experiments will investigate different facets of the immune system, the ubiquity of microorganisms and antibiotic sensitivity/resistance. Not intended for students majoring in biology. Open to first-year students. No prerequisite. Not offered in 2020-21. (SCI)

**BIOL 132: HUMAN BIOLOGY – HOW DOES MY BODY WORK? (4)****Wilson**

This lecture/laboratory course explores the basic principles and functions of the human body (such as digesting a meal, taking a breath, or fighting an infection) and puts them in the context of total body function. The aims of this course are to provide students with hands-on experience gathering physiological data, as well as with a basic knowledge of human health, which will provide them with a foundation from which they can ask informed questions of a physician about their own health and/or the health of their family members. Not intended for students majoring in biology. Open to first-year students. No prerequisite. Offered Term 1. (SCI)

**BIOL 133: MARINE ECOLOGY (2)****Godard, Wilson**

Students in this course will examine the ecology of marine ecosystems. Additionally, they will learn to recognize and identify characteristics and behavior of more than 100 marine species. This course is only open to students that will be participating in The Caribbean Environment Short Term course. Also listed as ES 133. Open to first-year students. Students will be enrolled by instructor. Not offered in 2020-21.

**BIOL 140: HUMAN GENETICS (4)****Beach**

In this combined lecture/laboratory course we explore the science behind such issues as human cloning, genetic testing, gene therapy, forensic DNA evidence, and genetically modified foods. Students gain an understanding of how the Human Genome Project may impact their lives and get a hands-on introduction to the laboratory analyses used in these studies. Not intended for students majoring in biology. Open to first-year students. No prerequisite. Not offered in 2020-21. (SCI)

**BIOL 200: SOPHOMORE BIOLOGY SEMINAR (2)****Carmichael**

This required two-credit course for biology majors is structured to allow you to reflect on how your liberal arts degree as well as your work in your biology major will prepare you for career options and life upon graduation. Specific topics we will explore will include careers in biology, the role of internships, graduate and professional school application process, resume and CV writing, financial management, wellness, and communication. Prerequisite: BIOL 207/207L, 220/220L, 236/236L, or permission. Sophomore or higher standing. Declared Biology majors only. Offered Term 2.

**BIOL 207: ECOLOGY (4)****Gleim, Godard**

As one of the core courses for the biology major, students explore the structure and function of the natural world. We examine the relationships between organisms and their physical and biological environment, global patterns of climate and biological life, patterns in population dynamics, as well as structure and change in communities of organisms. Also listed as ES 207. Open to first-year students. No prerequisite. Offered Term 1. (SCI: must take lab to fulfill SCI)

**BIOL 207L: LABORATORY FOR ECOLOGY (2)****Gleim, Godard**

Students explore local aquatic and terrestrial ecosystems as well as gain hands-on experience carrying out ecological research in this field laboratory course. Students will also have several opportunities to carry out their own independent research. Also listed as ES 207L. Corequisite: BIOL 207. Offered Term 1. (SCI)

**BIOL 220: HUMAN PHYSIOLOGY (4)****Carmichael, Wilson**

As one of the three core courses for the biology major, students explore physiological mechanisms of the human body on the cellular, tissue, organ, organ system, and whole-organism levels, with emphasis on the way in which the human body responds to various external and internal stimuli to maintain homeostasis. Open to first-year students. Prerequisite: CHEM 101 or CHEM 105 or permission. Offered Term 2. (SCI: must take lab to fulfill SCI)

**BIOL 220L: LABORATORY FOR HUMAN PHYSIOLOGY (2)****Carmichael, Wilson**

In this inquiry-based laboratory course, we explore many of the tools and techniques used in the study of physiological mechanisms. Students will employ hypothesis testing to explore these mechanisms and learn the essentials of scientific research and writing. Corequisite: BIOL 220. Offered Term 2. (SCI)

**BIOL 236: MOLECULAR AND CELL BIOLOGY (4)****Beach**

The diversity and complexity of different cell types found in multicellular organisms is extensive, yet all eukaryotic cells have the same basic molecular components. One of the three core courses for the biology major, this course provides an overview of cell structure, biological macromolecules, cellular reproduction, and gene structure and function. Prerequisite: CHEM 102 or CHEM 105, BIOL 220, or permission. Offered Term 1. (SCI: must take lab to fulfill SCI)

**BIOL 236L: LABORATORY FOR MOLECULAR AND CELL BIOLOGY (2)****Beach**

This project-oriented laboratory provides students with the opportunity to analyze and characterize DNA and other cellular molecules. The course is designed to give students experience with an array of molecular biological techniques. In addition, students are exposed to elements of research and experimental design in a directed framework. Corequisite: BIOL 236. Offered Term 1. (SCI)

**BIOL 240: ONE HEALTH: LINKING HUMAN, ANIMAL, AND ENVIRONMENTAL HEALTH (4)** **Gleim**

Nearly two-thirds of all human infectious diseases are transmissible to animals and vice versa. One Health is a world-wide movement which focuses on the intersectionality of human, animal, and environmental health and how interdisciplinary efforts can be made to better study and solve these problems. This seminar-based course will take a case study approach to explore concepts and approaches integral to One Health. Key diseases and issues related to human, animal, and environmental health for which this approach could or has been utilized will be explored along with its associated peer-reviewed literature. This course is specifically targeted towards pre-health, pre-vet, and public health students, along with students interested in field biology and environmental science. Also listed as ES/PH 240. Pre-requisites: BIOL/ES 207/207L, BIOL 236/236L, or permission. Not offered in 2020-21.

**BIOL 250: SPECIAL TOPIC: BACKYARD BIRDS (2)****Wilson**

Have you ever wondered what the names of the birds are that frequent your backyard birdfeeder? Do you wish you could identify bird songs? Are you curious about the biology and natural history of birds? In this field-oriented course, students will develop skills enabling them to identify, by both sight and sound, birds common to southwestern Virginia. We will explore a variety of habitats and observe the morphology and behavior of birds in their natural environments during several key aspects of their annual cycle (over-wintering, spring migration, and breeding). Not intended for students majoring in biology. Open to first-year students. Also listed as ES 250. No prerequisite. Offered Term 2.

**BIOL 260: HUMAN ANATOMY (4)****Godard, Wilson**

In this course, students have the opportunity to investigate the structure of the human body through independent exploration of texts and computer-based models of human anatomy. Students will be evaluated for their understanding of each anatomical system through written tests, lab practicals, and oral exams. This self-directed course is only for students who need human anatomy as a prerequisite for professional schools. Prerequisite: BIOL 220 and BIOL 220L. Permission of instructor is required. Offered Term 1.

**BIOL 290: INDEPENDENT STUDY (2 or 4)****Department**

Tutorials based on standard primary and secondary sources or may contain an experiential component. These studies, below the advanced level, must be planned and approved in consultation with a member of the department prior to registration. Maximum of 8 credits permissible. Offered any term.

**BIOL 310: EVOLUTION AND THE HUMAN CONDITION (4)****Department**

In this seminar students explore basic evolutionary concepts, such as natural selection, sexual selection, and population genetics and relate them to issues in human health and disease, the extinction crisis, and other impacts associated with human activity in the world. Our investigations will include an exploration of a variety of issues from the costs and benefits of aging, to the host-pathogen arms race, to the long-term viability of conservation programs for endangered species. Prerequisite: one of the three biology core courses (BIOL 207, BIOL 220, BIOL 236) or permission. Not offered in 2020-21.

**BIOL 312: MICROBIOLOGY (4)****Carmichael**

The term microorganism brings to mind the thought of disease and infection, yet plants and animals cannot exist without the many microbes in our world. This course provides a survey of microorganisms, focusing largely on the bacterial organisms and viruses that have the greatest impact on our existence. Prerequisites: BIOL 220 and BIOL 236; CHEM 102 or CHEM 105. Offered Term 2.

**BIOL 312L: LABORATORY FOR MICROBIOLOGY (2)****Carmichael**

This lab concentrates on techniques for culturing, handling, and identifying microorganisms. Students also carry out independent laboratory projects during the final weeks of the semester. Corequisite: BIOL 312. Offered Term 2.

**BIOL 313: INVERTEBRATE ZOOLOGY (4)****Wilson**

Invertebrates, members of the animal kingdom lacking a backbone, comprise 95 percent of the animals on Earth today. In this course students explore the anatomy, physiology, behavior, ecology, and taxonomy of this incredibly diverse group of animals. Prerequisite: BIOL/ES 207 or BIOL 220. Not offered in 2020-21.

**BIOL 313L: LABORATORY FOR INVERTEBRATE ZOOLOGY (2)****Wilson**

This laboratory provides students the opportunity to explore the anatomy of invertebrate organisms, the environments in which they live, and the techniques used to classify them. Exercises will be conducted in both the laboratory and the field. Beyond the designated laboratory meeting times, students will be expected to participate in a weekend field trip (Thursday - Sunday) to the Virginia Institute of Marine Science Eastern Shore Laboratory in late September. In addition, students will be expected to participate in 1-2 other day or evening excursions to study invertebrates. The cost of rooms and meals for the weekend trip will be shared by participants (\$150-200 required). Corequisite: BIOL 313. Not offered in 2020-21.

**BIOL 314: GENETICS (4)****Beach**

This course covers aspects of inheritance, including classical Mendelian and modern molecular genetics. Population genetics and variation will also be explored. Prerequisite: BIOL 236 or permission. Offered Term 2.

**BIOL 314L: LABORATORY FOR GENETICS (2)****Beach**

In this laboratory students gain practical experience in the techniques of both classical geneticists and molecular biologists. Laboratory investigations include breeding experiments with model organisms, as well as molecular genetic experiments using recombinant DNA methodology. Corequisite: BIOL 314. Offered Term 2.

**BIOL 315: COMPARATIVE VERTEBRATE ANATOMY (4)****Wilson**

Why are there no flying elephants? In this course we will compare the design and structure of vertebrate animals in relationship to the environments in which they evolve. We will emphasize the functional morphology of anatomical systems and major adaptive changes in the evolution of vertebrate structure. Prerequisite: BIOL 220. Offered Term 1.

**BIOL 315L: LABORATORY FOR COMPARATIVE VERTEBRATE ANATOMY (2)****Wilson**

This laboratory involves detailed dissections and comparisons of organ systems in the lamprey, shark, and cat. Corequisite: BIOL 315. Offered Term 1.

**BIOL 316: WILDLIFE DISEASE (4)****Gleim**

This lecture/ lab course will provide a general understanding of disease ecology and examine both common and newly emerging diseases that are known to impact wildlife. We will also work to better understand the roles these diseases play in population regulation, conservation of rare and endangered species, and the impacts that these diseases can have on human and domestic animal health. Lab components of the course will involve both field and laboratory-based experiences involved in routine testing of wildlife and/or vectors for pathogens. Also listed as ES/PH 316. Pre-requisites: BIO/ES 207/207L, BIO 236/236L, or permission. Offered Term 2.

**BIOL 317: BIOLOGICAL PSYCHOLOGY (4)****Bowers**

Also listed and described as PSY 317. Prerequisites: PSY 141 (or permission) and BIOL 220. Not offered in 2020-21.

**BIOL 322: DEVELOPMENTAL BIOLOGY (4)****Beach**

Development from the fertilized egg to a complete adult organism requires a precisely coordinated series of events involving molecular, cellular, and organismal mechanisms. This course provides an integrative survey of animal development, with a focus on those unifying mechanisms that are common to all developing embryos. Prerequisite: BIOL 236 or BIOL 314. Not offered in 2020-21.

**BIOL 322L: LABORATORY FOR DEVELOPMENTAL BIOLOGY (2)****Beach**

This laboratory is designed to give the student hands-on experience in experimental embryology. The first part of the course is devoted to techniques for handling, culturing, and manipulating invertebrate and vertebrate embryos. Students then apply these techniques in self-designed independent projects during the remaining half of the semester. Corequisite: BIOL 322. Not offered in 2020-21.

**BIOL 323: ANIMAL BEHAVIOR (4)****Godard**

Analyses of animal behavior incorporating ethological, ecological, and evolutionary perspectives. This interdisciplinary course covers the development, underlying mechanisms, adaptive value, and evolution of behavior. Also listed as PSY 323. Prerequisite: BIOL/ES 207 or BIOL 220. Not offered in 2020-21.

**BIOL 323L: LABORATORY FOR ANIMAL BEHAVIOR (2)****Godard**

Observational and experimental techniques in field and laboratory settings. The lab culminates in independent group research projects. Beyond the designated laboratory meetings, there may be one day-long field trip to observe patterns of behavior in other species. The cost for this trip will be shared by participants. Also listed as PSY 323L. Corequisite: BIOL 323. Not offered in 2020-21.

**BIOL 328: FIELD VERTEBRATE ZOOLOGY (4)****Godard**

In this lecture/lab course, we will use vertebrates as our focus as we explore issues of evolution, ecology, physiology, behavior and conservation as well as develop skills associated with studying vertebrates in the field. Beyond the scheduled classes, students are required to participate in a 3-day weekend field trip to the Eastern Shore of Virginia to study avian biodiversity as well as several evening excursions to examine patterns of amphibian biodiversity. Course fee of \$150-200 is required. Prerequisite: BIOL/ES 207 or permission from instructor. Also listed as ES 328. Offered Term 2.

**BIOL 332: IMMUNOLOGY (4)****Department**

This seminar-style course is intended to provide an in-depth analysis of the cell and molecular biology of the human immune system, focusing on antibody structure and function, cells and tissues of the immune system, and the genetic basis for antibody diversity. Advances in studies of immune deficiencies, autoimmune diseases, the allergic response, transplant rejection, and cancer are also covered. Prerequisites: BIOL 220 and BIOL 236 and CHEM 101 or CHEM 105. Not offered in 2020-21.

**BIOL 332L: LABORATORY FOR IMMUNOLOGY (2)****Department**

This laboratory will provide students with hands-on experience on classical experimental techniques used in the field of immunology research. Laboratory methods will focus on molecular and biochemical aspects of immunology.

Corequisite: BIOL 332. Not offered in 2020-21.

**BIOL 337: ORNITHOLOGY (4)****Wilson**

With nearly 10,000 recognized species, the taxonomic class Aves is one of the most diverse groups of animals on earth. In this lecture course students will explore the anatomy, physiology, behavior, taxonomy, evolution, and life history of birds. Prerequisite: BIOL/ES 207 or permission from instructor. Also listed as ES 337. Prerequisite: BIOL/ES 207 or permission. Not offered in 2020-21.

**BIOL 337L: LABORATORY FOR ORNITHOLOGY (2)****Wilson**

Students in this field laboratory course will explore the life history of birds, observe them in their natural environments, and learn to identify them by sight and sound. Students will be expected to participate in a weekend field trip (to either the North Carolina coast or Eastern Shore of Virginia) and in several other morning/evening activities. The cost of rooms and meals for the weekend trip will be shared by participants (\$150-200 required). Corequisite: BIOL 337. Also listed as ES 337. Prerequisite: BIOL/ES 207 or permission. Not offered in 2020-21.

**BIOL 341: PLANT BIOLOGY (4)****Gleim**

In this course, students will gain a foundational comprehension of the structure, function, and diversity of plants, and will be challenged to build an integrated understanding of plants, from an awareness of their cellular and molecular biology to their roles in an ecosystem. We will then tap into this knowledge to engage in active learning experiences to recognize and appreciate practical applications of plant biology, including conservation, environmental sustainability, biotechnology, and the important connections of plants to society. Also listed as ES 341. Prerequisite: BIOL 207. Offered Term 1.

**BIOL 341L: LABORATORY FOR PLANT BIOLOGY (2)****Gleim**

Laboratory sessions will provide hands-on experiences in laboratory and field settings. A significant portion of the lab will be field-based, with time being spent learning to identify native and common invasive plants, with particular focus on woody species. Students will conduct a multi-week research project and present their findings. Also listed as ES 341L. Co-requisite: BIOL 341. Offered Term 1.

**BIOL 351: BIOCHEMISTRY (4)****Nguyen**

The chemical nature of biological molecules and the relationship between their structures and function; the function of carbohydrates, nucleic acids, proteins, and lipids in living systems. Introduction to metabolism. Also listed as CHEM 351. Prerequisites: CHEM 222 and CHEM 222L; or the equivalent. Offered Term 1.

**BIOL 351L: LABORATORY FOR BIOCHEMISTRY (2)****Nguyen**

Also listed and described as CHEM 351L. Corequisite: BIOL 351. Offered Term 1.

**BIOL 352: ADVANCED BIOCHEMISTRY (4)****Nguyen**

Also listed and described as CHEM 352. Prerequisite: BIOL 351. Offered Term 2.

**BIOL 352L: LABORATORY FOR ADVANCED BIOCHEMISTRY (2)****Nguyen**

Also listed and described as CHEM 352L. Corequisite: BIOL 352. Offered Term 2.

**BIOL 357: CONSERVATION BIOLOGY (4)****Gleim**

In this course, students will apply active learning strategies to build a conceptual foundation for conservation biology, including conservation values and ethics. Building on this foundation, we will explore the primary threats to biological conservation, including habitat degradation, overexploitation, invasive species, and biological impacts of climate change. We will also explore how to apply this knowledge through learning about and utilizing various professional approaches used to solve conservation problems. Students will also be expected to participate in a weekend field trip to Front Royal Virginia & Washington D.C. to explore conservation biology research and efforts occurring at the Smithsonian. Course fee of \$150-200 required. Also listed as ES 357. Prerequisites: BIOL/ES 207 and 207L or permission. Not offered in 2020-21.

**BIOL 357L: LABORATORY FOR CONSERVATION BIOLOGY (2)****Gleim**

Laboratory activities will cultivate an understanding of real-world, hands-on conservation biology through completing various field- and computer-based activities, as well as a multi-week research project that will involve experimental design and methodology development. As a whole, this course will involve the use of various field techniques to collect data, analysis and interpretation of data, and presentation of research findings. In addition, students will be

trained to use common professional tools and methods, including geographic information systems (specifically ArcGIS), which aid in the management and preservation of biodiversity. Corequisite: BIOL 357. Not offered in 2020-21.

**BIOL 364: BIOGEOCHEMISTRY: AN ANALYSIS OF GLOBAL CHANGE (4)**

**Carmichael**

Much like the human body, the Earth's climate and ecological systems have been finely tuned to maintain homeostasis. In the human body, this occurs via feedback loops and exchange between major organ systems. In the Earth's climate and ecological systems, this balance is maintained by the flow of energy and materials. Biogeochemistry is the study of this flow of energy and materials within the Earth's planetary system. In this course, we will cover processes that control the cycling of C, N, and P and other biochemical elements in terrestrial and aquatic systems, with special emphasis placed on the coupling between human and natural systems. Topics include the origin of Earth and the development of elemental cycles, the Earth as a chemical system, the biogeochemical cycling of elements in the atmosphere, lithosphere, and biosphere, the global cycles of H<sub>2</sub>O, C, N and P, and the expanding human footprint on biogeochemical processes. Prerequisites: CHEM 101/102 or CHEM 105, BIOL 207 or BIOL/ES 117. Also listed as ES 364. Not offered in 2020-21.

**BIOL 364L: BIOGEOCHEMISTRY LABORATORY (2)**

**Carmichael**

The biogeochemistry laboratory will introduce students to common analytical techniques used to assess the biogeochemical transformation of nutrients in the environment. Co-requisite: BIOL 364. Also listed as ES 364L. Not offered in 2020-21.

**BIOL 390: INDEPENDENT STUDY (2 or 4)**

**Department**

Independent study conducted at the advanced level. Application must be made with faculty prior to registration. Offered any term.

**BIOL 391: INDEPENDENT RESEARCH IN BIOLOGY (4)**

**Department**

This course is intended for students conducting independent scientific research. At the beginning of the semester in which the student enrolls in this course, a proposal for the research project will be developed in consultation with the faculty supervisor. The project must involve laboratory and/or field research with significant data collection and analysis. The student will be expected to produce a formal scientific report at the conclusion of the project, which should include a review of the scientific literature relevant to the study. Registration for this course must occur before the semester in which the research is to be conducted. Prerequisites: two of the three biology core courses (BIOL 207, BIOL 220, or BIOL 236). May not be taken in the second semester of the senior year without prior departmental approval. Offered any term.

**BIOL 399: INTERNSHIP (4)**

**Department**

Application must be made with faculty prior to registration. May be proposed any term.

**BIOL 471: SENIOR CAPSTONE (2)**

**Carmichael**

All majors are required to take this course during the fall term of their senior year. Students in this capstone course will draw upon course content from their major to exploring common readings and present on a relevant topic of interest. In addition, each student will prepare a portfolio summarizing her academic experiences (to include a curriculum vitae, resume, and cover letter, as well as summaries of coursework and skills attained, internships and abroad experiences). Offered Term 1.

**BIOL 480: SENIOR THESIS (4, 4)**

**Department**

Students are expected to carry out a year-long research project (includes Short Term). The research project will be summarized in a paper of publication quality. If a student's status and thesis meet the requirements for honors, then BIOL 480 will be converted to BIOL 490. Application must be made with faculty prior to registration.

**BIOL 490: SENIOR HONORS THESIS (4, 4)**

**Department**

Students should not register for BIOL 490. Research is initially conducted as BIOL 480: Senior Thesis. Honors status will be determined in the spring pending successful defense.