

BIOLOGY (BIOL)

BIOL 100 Big Ideas in Biology (4 Credits)

An exploration of significant questions and integrative concepts in Biology, their grounding in the process of scientific discovery and application, and their broader relevance to society. Designed for first-year students. Although topics vary, the courses also seek to improve students' communication skills beyond the written word.

College Curriculum: C100

BIOL 104 Intro Topics in Biology (1-3 Credits)

Topics are taught at an introductory level and have no prerequisites. Credits do not count towards either the biology major or minor, but some courses may count towards NQR or COLL requirements. If there is no duplication of topic, courses with this number may be repeated for credit. Appropriate for both STEM majors and non-STEM majors.

BIOL 106 Disease, Biomedicine, and Biomedical Research (3 Credits)

Introduction to the biology of common devastating diseases. Topics include the biological basis of specific disease and general approaches for accessing biomedical information, interpreting data from clinical trials, and appreciating the methodological approaches used by biomedical researchers to investigate disease. Not applicable toward the minimum requirements for a major or minor in Biology.

College Curriculum: C200

Domain: NQR

BIOL 115 Memory and Learning: A Practical Guide for Students (2 Credits)

A review of research on the structure and function of brain areas involved in learning and memory in relation to research on the development of expertise. Includes a review of methods to improve learning efficiency and quality.

BIOL 150 First-Year Seminar (4 Credits)

An exploration of a specific topic in Biology. A grade of C- or better fulfills the COLL 150 requirement. Although topics vary, the courses emphasize academic writing skills, reading and analysis of texts, and discussion.

College Curriculum: C150

BIOL 201 Freshman Research (1 Credit)

Introduction to research with faculty mentor for freshmen identified by the Biology Department as having an unusually strong Biology background. Students cannot register themselves for this course.

BIOL 203 Introduction to Molecules, Cells, Development (3 Credits)

Lectures explore the molecular and cellular characteristics of living organisms including cell structure, biochemistry, metabolism, molecular genetics, and cellular processes in development. Recommended for science majors. Presupposes strong background in high school biology and chemistry. Three class hours. (formerly BIOL225 lecture).

Corequisite(s): BIOL 203D, BIOL 203L

College Curriculum: C200

Domain: NQR

BIOL 203D Intro Molec, Cells, Devp Disc (0 Credits)

Corequisite(s): BIOL 203, BIOL 203L

BIOL 203L Introduction to Molecules, Cells, Development Laboratory (1 Credit)

Corequisite(s): BIOL 203, BIOL 203D

Additional fees apply

Domain: NQR

BIOL 204 Introduction to Organisms, Ecology, Evolution (3 Credits)

Course is designed for potential biology majors. Lectures explore the diversity of organisms, their interactions with each other and the environment, and the evolutionary processes that produce diversity. Topics include Mendelian genetics, major taxonomic groups, ecology, and evolution. Presupposes strong background in high school biology. Three class hours. (formerly BIOL 220 lecture).

Corequisite(s): BIOL 204D, BIOL 204L

College Curriculum: C200

Domain: NQR

BIOL 204D Intro Org, Ecol, Evol Disc (0 Credits)

Corequisite(s): BIOL 204, BIOL 204L

BIOL 204L Introduction to Organisms, Ecology, Evolution Laboratory (1 Credit)

Corequisite(s): BIOL 204, BIOL 204D

Additional fees apply

Domain: NQR

BIOL 240 Topics in Biology (1-3 Credits)

Topics are taught at an introductory level and have no prerequisites. Material is distinct or complementary to the BIOL203/204 courses, such that students will benefit from taking both. If there is no duplication of topic, courses with this number may be repeated for credit, although no more than three BIOL240 credits can count towards the biology major or minor.

BIOL 298 Freshman Honors Biology Laboratory I (1 Credit)

The lab will focus on a genomics approach to bacterial pathogenicity and cell fate specification in the vertebrate nervous system. Students will master basic lab skills related to the projects, construct cDNA and genomics libraries, and conduct high throughput sequencing.

Additional fees apply

BIOL 299 Freshman Honors Biology Laboratory II (1 Credit)

The lab will focus on a genomics approach to bacterial pathogenicity and cell fate specification in the vertebrate nervous system. Students will conduct in depth bioinformatics analysis of the sequenced cDNA and genomic libraries.

Additional fees apply

BIOL 301 Engineering Life: Scientific, Cultural, and Ethical Aspects of Synthetic Biology (3 Credits)

Pre-req: One year of science or math coursework at the introductory level: MATH 111 and 112 or CSCI 141 and 241 or BIOL 220 and 226 (now re-numbered as 203 and 204) or CHEM 103 and CHEM 207 or 209 Co-req: Participation in W&M iGEM Team The course will entail participation in the iGEM (International Genetically Engineered Machine) team and competition over the summer and fall semesters. Students will design and build a novel genetic device and learn about the scientific, ethical, and cultural aspects of synthetic biology.

Prerequisite(s): (MATH 111 and MATH 112) or (CSCI 141 and CSCI 241) or (BIOL 220 or BIOL 204 and BIOL 225 or BIOL 203) or (CHEM 103 and CHEM 207)

College Curriculum: C30C

BIOL 302 Integrative Biology: Animals (4 Credits)

The study of the evolution, classification, ecology, behavior, development and functional systems of the major animal phyla. Certain aspects of human biology will also be covered.

Prerequisite(s): (BIOL 220 or BIOL 204) and (BIOL 225 or BIOL 203)

Corequisite(s): BIOL 302L

BIOL 302L Integrative Bio-Animals Lab (0 Credits)

Lab: Integrative Bio-Animals

Corequisite(s): BIOL 302

Additional fees apply

BIOL 303 Introduction to Biological Research (1 Credit)

Introduction to biological research in the lab or field conducted under the supervision of a faculty advisor. Biol 303 may be used as a gateway to independent research in Biology (e.g. BIOL 403). The course is graded pass/fail and may be repeated once with the same or another faculty advisor. Hours to be arranged. By instructor permission only.

BIOL 304 Integrative Biology: Plants (4 Credits)

An examination of major groups of photosynthetic organisms, with emphasis on terrestrial plants and their interactions with other organisms. Their structure, reproduction, physiology and ecological importance are emphasized in an evolutionary context. Three class hours, three laboratory hours.

Prerequisite(s): (BIOL 220 or BIOL 204) and (BIOL 225 or BIOL 203)

Corequisite(s): BIOL 304L

BIOL 304L Integrative Biology: Plants Lab (0 Credits)

Corequisite(s): BIOL 304

Additional fees apply

BIOL 305 Integrative Biology: Plants (without lab) (3 Credits)

An examination of major groups of photosynthetic organisms, with emphasis on terrestrial plants and their interactions with other organisms. Their structure, reproduction, physiology and ecological importance are emphasized in an evolutionary context. Three class hours. Integrative Biology: Plants must be taken with its associated laboratory to meet the "Integrative" requirement for biology majors

Prerequisite(s): (BIOL 220 or BIOL 204) and (BIOL 225 or BIOL 203)

BIOL 306 Microbiology (4 Credits)

Introduction to the biology of prokaryotes and viruses. Classical topics such as growth, metabolism and genetics, ecology, and molecular biology are covered in the lecture section. The laboratory introduces techniques routinely in microbiology such as sterile techniques, staining and microscopy, biochemical assays, microbial ecology, and genetics. Three class hours, three laboratory hours.

Prerequisite(s): (BIOL 220 or BIOL 204) and (BIOL 225 or BIOL 203)

Additional fees apply

BIOL 310 Molecular Cell Biology (3 Credits)

An introduction to the principles by which eukaryotic cells function with an emphasis on the molecular biology of cells and experimental approaches to their analysis.

Prerequisite(s): (BIOL 204 or BIOL 220) and (BIOL 203 or BIOL 225) and CHEM 206 (may be taken concurrently)

BIOL 311 Ecology (3 Credits)

Ecology is the study of interrelationships between species and their environments, from an organismal to community scale. Lecture topics will include physical habitat parameters, organismal adaptations to physical conditions, population growth models, life history theory, biodiversity, species interactions, and ecosystem science in a changing biosphere.

Prerequisite(s): (BIOL 203) and (BIOL 204)

BIOL 312 Evolution of Organisms (3 Credits)

An introduction to the mechanisms and outcomes of evolution.

Examples are drawn from many disciplines (e.g. genetics, behavior, and paleontology) to discuss how researchers study the evolution of organisms and develop and test evolutionary theory using integrative approaches.

Prerequisite(s): (BIOL 203 or BIOL 225) or (BIOL 204 or BIOL 220)

BIOL 318 Conservation Biology (3 Credits)

An introduction to the fundamentals of conservation biology and an examination of current conservation issues. Topics include threats to biodiversity, endangered species management, and the interplay of politics, economics, or societal values in conservation decisionmaking.

Prerequisite(s): (BIOL 220 and BIOL 221) or BIOL 204

BIOL 320 Pre-Med Experiential-Learning (1 Credit)

Pre-med Experiential-Learning Edge Classes (PEEC) are 1-credit topics courses consisting of classroom training combined with either supervised clinical experience, conversations with experienced physicians, deep investigation into the diagnostic process, or summer biomedical research. A maximum of two credits of PEEC courses can count as electives towards the Biology major.

BIOL 320A Applied Clinical Experience (ACE) (1 Credit)

This 1-credit course is a collaborative clinical shadowing experience program between VCU Health's W&M clinic and the Biology Department. This is a BIOL class that meets every week on campus for 50 minutes and requires a weekly 4-hour practicum at the "VCU Health at William & Mary" clinic (ideally either ~8-12AM or ~12-4PM, to be scheduled around student's other classes). For liability reasons, students sign up as independent observers through VCU. They arrive at the clinic in business casual clothes and ready to eagerly follow whichever physician or other medical professional they are assigned to for 4 hours. The classroom meeting period is an opportunity for academic reflection on the clinical experience, as well as broadening the experience through discussion of short readings about the state of medical education and healthcare. Grade is based on reliable attendance and professional performance at the clinic and participation in class discussion and brief writing assignments (see breakdown below). This course is designed for those interested in gaining shadowing experience in advance of applying for medical school or other health careers, especially students who do not have other options for gaining such experience.

BIOL 320B Research Experience in All-around Cardiovascular Health (REACH) (1 Credit)

This 1-credit course is preparation for a summer research experience at VCU Health in Richmond, where selected students undertake a paid, 10-week summer research experience with a mentor at VCU's Pauley Heart Center. Approximately 10 W&M students annually gain research and professional experience in this multi-university collaborative program. This course is a required component of the program, providing experience at planning research projects, following professional norms in a medical research setting, critically reading scientific literature, and disseminating research through conference presentation and journal publication.

BIOL 320C Medical Experience & Engagement Talks (MEET) (1 Credit)

This class is a 50-minute moderated weekly virtual guest expert series in which invited medical guests share their experiences within the medical profession and answer questions posed by students. Each class period requires a short pre-class reading relating to the upcoming guest, a short paragraph of writing in response to the reading/exercise (submitted before class via Blackboard), and active participation in the weekly meeting through asking prepared questions when called on by instructor.

BIOL 320D Birds & Medicine (BAM) (1 Credit)

Increasingly, physicians rely on technology for diagnosis and physicians-in-training spend 40% of their time looking at their computers as opposed to only 12% looking at patients.[1] In response, some medical education programs are teaching "visual thinking strategies" in collaboration with art museums. This 1-credit course was inspired by a unit taught at Harvard Medical School by Rose Goldman using the careful combining of visual "field marks" on unfamiliar birds to hone the cognitive skills required for the observational component of diagnosis of patients.

Numerous physicians (Stephen Davis, Miles Grunvald, Ramon Grimalt et al., A.J. Lees, Farokh Jamalyaria, Nicholas Koontz & Darel Heitkamp, etc.) have written formally or informally about the similarity between bird identification and medical diagnosis. We will read every available articles of this sort during the semester. [1] Block L, Habicht R, Wu AW, et al. 2013. In the wake of the 2003 and 2011 duty hours regulations, how do internal medicine interns spend their time? J Gen Intern Med. 28(8):1042-1047.

BIOL 325 Introduction to Quantitative Biology (4 Credits)

Introduction to the mathematical tools used in quantitative analysis and modeling of biological systems. The goal is to develop quantitative reasoning skills through the use of mathematical modeling, data analysis, and computer simulation. Biological topics include population ecology, microbiology, epidemiology, evolutionary genetics, systems biology, and gene regulation.

Prerequisite(s): (BIOL 204) and (BIOL 203) and (MATH 111 or MATH 131)

BIOL 327 Intro to Biostatistics (3-4 Credits)

An introduction to statistics and research design, including statistical inference, hypothesis testing, descriptive statistics and commonly used statistical tests. Emphasis is placed on the application of quantitative techniques in the biological sciences and solution methods via use of the computer. Includes a separate lab (BIOL 327L) when offered as a 4 credit course.

Prerequisite(s): (BIOL 203 or BIOL 225) and (BIOL 204 or BIOL 220) and (MATH 111 or MATH 131)

BIOL 345 Neurobiology (3 Credits)

An introduction to the fundamental concepts of neurobiology; this course will cover basic neuroanatomy and electrophysiology, but will emphasize the molecular basis of neuronal development and signaling, including sensory systems, motor systems, learning and memory, behavior and disease of the nervous system.

Prerequisite(s): BIOL 203 or BIOL 225

BIOL 377 Bioengineering and Synthetic Biology (3 Credits)

An introduction to the principles of bioengineering with a focus on the fundamentals of synthetic biology. The course will cover current applications of synthetic biology to medicine, global health, biotechnology, energy, environment and sustainability, agriculture, bio-inspired design, and novel living materials.

Prerequisite(s): (BIOL 203) and (BIOL 204)

BIOL 401 Evolutionary Genetics (3 Credits)

Evolution as an ongoing process, rather than as a history, is emphasized. Topics include theoretical and experimental population genetics, ecological genetics, interactions of evolutionary forces, genetic divergence, speciation, and molecular evolution.

Prerequisite(s): (BIOL 220) and (BIOL 225) and BIOL 312

BIOL 403 Research in Biology (1-3 Credits)

Independent laboratory or field research under the supervision of a faculty member. A written report is required. No more than three hours may be applied toward the minimum 37 required for a biology major. Hours to be arranged.

BIOL 404 Special Topics in Biology (0-4 Credits)

Advanced study of topics not covered by existing courses. Subjects, prerequisites, and instructors will vary from year to year. At minimum, these courses have a prerequisite of BIOL203 and/or BIOL204. Credits can count towards the major or minor. If there is no duplication of topic, courses with this number may be repeated for credit.

BIOL 404L Topics in Biology Lab (0-1 Credits)**BIOL 405 Research Seminar Series (0 Credits)**

This seminar is to be attended on a near weekly basis by Biology faculty and all students doing research in the Biology Department. Students in BIOL 201, BIOL 303, BIOL 403 and BIOL 495 are expected to enroll.

BIOL 406 Molecular Neuroscience Lab (1 Credit)

An introduction to the use of molecular biology methods in neuroscience such as fluorescent protein expression vector design, basic cloning of plasmid DNA, its purification and expression in cells of the brain so that they can be imaged and analyzed.

Prerequisite(s): BIOL 310 or BIOL 345

BIOL 408 Virology Lab (1 Credit)

The Virology lab course is designed to give students the opportunity to gain hands-on experience in common laboratory techniques in modern virology. Students will learn first-hand how to perform infectious assays, microscopy techniques, and molecular protocols to detect, enumerate, and characterize viruses in environmental samples. As part of this lab, students will attempt to isolate novel bacteriophages from environmental samples. Credits count toward major. Fulfills the upper level Biology laboratory requirement.

Prerequisite(s): BIOL 409 (may be taken concurrently)

BIOL 409 Virology (3 Credits)

This course gives an overview of fundamental concepts in virology. Topics include the discovery of viruses, principles of viral structure, viral morphogenesis, viral detection methods, viral vaccines, and ecological significance of viruses. A strong emphasis is placed on molecular mechanisms of viral replication.

Prerequisite(s): (BIOL 204 or BIOL 220) and (BIOL 203 or BIOL 225) and (BIOL 204L or BIOL 221) and (BIOL 203L or BIOL 226) and (BIOL 310 or BIOL 406 or BIOL 442)

BIOL 409L Virology Lab (1 Credit)

The Virology lab course is designed to give students the opportunity to gain hands-on experience in common laboratory techniques in modern virology. Students will learn first-hand how to perform infectious assays, microscopy techniques, and molecular protocols to detect, enumerate, and characterize viruses in environmental samples. As part of this lab, students will attempt to isolate novel bacteriophages from environmental samples. Credits count toward major. Fulfills the upper level Biology laboratory requirement.

Prerequisite(s): BIOL 409 (may be taken concurrently)

Additional fees apply

BIOL 410 Animal Behavior (3 Credits)

The study of vertebrate and invertebrate behaviors as adapted traits under the influence of both genes and the environment. Animal behavior, including that of humans and endangered species, will be placed in an ecological and evolutionary context.

Prerequisite(s): BIOL 204 or BIOL 220

BIOL 410D Animal Behavior-Demo (0 Credits)

BIOL 411 Ecology Lab (1 Credit)

Ecology is the study of interrelationships between species and their environments, from an organismal to ecosystem scale. The Ecology Lab will complement Ecology Lecture topics by providing hands-on experience with ecological research techniques in local habitats (forest, lake, stream, and estuary). Natural history of local flora and fauna will be emphasized.

Prerequisite(s): (BIOL 203) and (BIOL 204)

Corequisite(s): BIOL 311

BIOL 412 Vascular Plant Systematics (4 Credits)

A study of the principles and research methods of vascular plant systematics, emphasizing classification, evolution, and comparative morphology of the major families of vascular plants.

Prerequisite(s): BIOL 205 or BIOL 305

Corequisite(s): BIOL 412L

BIOL 412L Vascular Plant System-Lab (0 Credits)

Corequisite(s): BIOL 412

Additional fees apply

BIOL 413 Plant Diversity and Identification (1 Credit)

An introduction to vascular plant diversity at the species level with focus on plants of Virginia's Coastal Plain. Students will acquire essential background in research techniques and resources, life-history variation, structural evolution, and conservation principles that underpin professional field botanical skills.

Prerequisite(s): BIOL 204

Corequisite(s): BIOL 413L

BIOL 413L Plant Diversity and Identification Laboratory (2 Credits)

The laboratory course is designed to build skills in plant identification through an immersive hands-on experience with local plants to facilitate professional competence for the conservation biology workplace, enhance research skills, and foster personal enrichment. Digital exercises as well as regular field trips to the College Woods and campus plants will comprise the learning environment.

Prerequisite(s): BIOL 204

Corequisite(s): BIOL 413

BIOL 415 General Endocrinology (3 Credits)

A survey of the neuroendocrine physiology of major systems including the hormones of the hypothalamus, pituitary, adrenal, pancreas, thyroid, GI tract, and reproductive systems. The molecular-cellular control of general metabolism and reproduction in both health and disease is considered.

Prerequisite(s): (BIOL 310 or BIOL 406) and (CHEM 206)

BIOL 415L Endocrinology-Lab (0 Credits)

Corequisite(s): BIOL 415

BIOL 416 Intro to Ornithology (4 Credits)

Lectures, laboratory exercises, field experiments and birding trips will provide a comprehensive introduction to the ecology and evolution of birds. Phylogenetic relationships, behavior, conservation, and identification of Virginia's avian fauna will be stressed.

Prerequisite(s): BIOL 204 or BIOL 220

Additional fees apply

BIOL 417 Population and Community Ecology (4 Credits)

Discussion of the structure and dynamics of ecological populations and biotic communities. Emphasis will be on environmental constraints and species interactions that control population growth and determine both diversity and similarities in community structure and function.

Prerequisite(s): (BIOL 204 (may be taken concurrently) or BIOL 220) and (BIOL 325 or BIOL 327)

Additional fees apply

BIOL 418 Functional Ecology (3 Credits)

Concepts and approaches in physiological ecology, biomechanics and ecological morphology. The course emphasizes critical thinking, discussion, and student presentations on journal articles from the primary literature. Hypothesis formulation and methods of data collection and analysis will be studied.

Prerequisite(s): BIOL 302 or BIOL 304 or BIOL 305

BIOL 419 Plant Development and Physiology (4 Credits)

An investigation of major topics in plant biology, encompassing plant development, reproduction, energetics and physiology, and the use of genetic, molecular, and biochemical approaches to elucidate major outstanding questions. The accompanying lab will introduce students to model plant systems and a range of genetic, molecular, and histological techniques.

Prerequisite(s): (BIOL 304 or BIOL 305)

Additional fees apply

BIOL 420 Genetic Analysis (3 Credits)

Discussion of classical and modern genetics. Topics will be drawn from the following: Mendelian inheritance, recombination and linkage, cytogenetics, model genetic systems, mutation analysis, mitochondrial, and chloroplast genetics.

Prerequisite(s): (BIOL 203 or BIOL 225) and (BIOL 204 or BIOL 220))

BIOL 422 Introduction to Bioinformatics (3 Credits)

This course provides an introduction to bioinformatics, covering common topics including alignments, phylogenomics, transcriptomics and genomics, as well as emergent uses of machine/deep-learning across various topics in biology.

Prerequisite(s): (BIOL 203 and BIOL 204) and (MATH 111 or MATH 131)

Corequisite(s): BIOL 422L

BIOL 422L Introduction to Bioinformatics Laboratory (1 Credit)

This lab course provides a hands-on introduction to bioinformatics. This lab course will develop essential bioinformatic skills, linking theory to application using 'big-data' to address fundamental questions in biology.

Corequisite(s): BIOL 422

BIOL 424 Applied Programming for Biology (3 Credits)

This course seeks to provide a solid programming framework for analyzing large biological datasets, with Python as the primary language. Instruction will be divided between lectures, self-guided coding exercises, and instructor-guided coding sessions. Students will use real-world datasets, including genomic datasets and/or massive natural history datasets, as case studies in this course.

Prerequisite(s): (BIOL 203 and BIOL 204)

BIOL 426 Aquatic Ecology (4 Credits)

Introduction to the ecology of aquatic systems; discussion of the important physical and chemical characteristics of aquatic environments and the adaptations of organisms living in water; community structure and the important processes affecting it, including major aspects of water pollution. Three class hours, three laboratory hours.

Prerequisite(s): BIOL 204 or BIOL 220

Additional fees apply

BIOL 426L Aquatic Ecology-Lab (0 Credits)*Corequisite(s):* BIOL 426*Additional fees apply***BIOL 427 Wetland Ecosystems (4 Credits)**

An investigation of structure and function of wetland ecosystems, considering their formation and distribution at local, regional and continental scales. Interactions amongst biologic, geologic and hydrologic components in wetland development will be presented in lecture, lab and field exercises. Three class hours, three laboratory hours.

Prerequisite(s): (BIOL 203 or BIOL 225) and (BIOL 204 or BIOL 220)*Additional fees apply***BIOL 428 Entomology (3 Credits)**

Insects are one of the most abundant and diverse groups of animals on the planet. They provide crucial services for many ecosystems, including pollination, their role in food webs, soil formation and mixing, plant community control, biological control of pests, and more. This course is an introduction to the biology of insects and is designed to give you an overview of the field of entomology. In this course, you will learn about several topics within the field of entomology, including evolution, classification, morphology, physiology, behavior, and ecology. Class will be a mixture of lectures, discussions, and activities.

Prerequisite(s): (BIOL 203 or BIOL 225) and (BIOL 204 or BIOL 220)**BIOL 428L Entomology Lab (1 Credit)**

This laboratory course is designed to build skills in insect collection, preservation, and identification through immersive hands-on experiences with local insect fauna. Regular field trips will take students into various habitats to collect, document, and observe insects. This course is heavily field based and will take place in a variety of environments, locations, and weather. Laboratory days will often conclude with designated curation time, where students will work to prepare, pin, and identify the insects collected during the field days. Three laboratory hours.

Corequisite(s): BIOL 428*Additional fees apply***BIOL 430 Mechanisms of Bacterial Symbiosis (3 Credits)**

Symbiotic relationships encompass a spectrum from parasitism to mutualism. This class will explore the molecular basis of bacterial diseases and the basis of bacterial host mutualistic relationships.

Prerequisite(s): BIOL 440 or BIOL 306**BIOL 432 Animal Physiology (3 Credits)**

This course discusses the function of the animal as a whole as indicated by the physiology and interrelationships of different organs and organ systems. The emphasis is on vertebrates, with comparative examples from selected invertebrates. Three class hours.

Prerequisite(s): (CHEM 206 and BIOL 302) or (CHEM 206 and BIOL 345 and PSYC 313 and BIOL 310)**BIOL 432L Animal Physiology-Lab (1 Credit)**

In this lab course, students conduct hands-on experiments and demonstrations to better understand animal physiology and interrelationships between different organs and organ systems. The emphasis is on vertebrates, with comparative examples from selected invertebrates. Three laboratory hours. There is a fee associated with the laboratory.

Prerequisite(s): BIOL 432 (may be taken concurrently)**BIOL 433 Developmental Biology (3 Credits)**

An introduction to embryonic and post-embryonic development processes in animals emphasizing both molecular and organismal mechanisms governing cellular differentiation, and the generation of form, shape, and function. Applications of developmental biology to human disease will also be covered including birth defects, stem cell biology, and regenerative medicine.

Prerequisite(s): (BIOL 203) and (BIOL 204)**BIOL 434 Developmental Biology Lab (1 Credit)***Prerequisite(s):* BIOL 433 (may be taken concurrently)**BIOL 437 Immunology (3 Credits)**

This course gives an overview of the cells and molecules that compose the immune system and the mechanisms by which they protect the body against foreign invaders, with emphasis on current experimental approaches and systems.

Prerequisite(s): or BIOL 203 or BIOL 204) and (BIOL 310 or BIOL 314 or BIOL 442)**BIOL 437L Immunology Lab (1 Credit)**

An introduction to current techniques available to study immune responses in mice. Includes tissue culture of lymphocytes, measuring antibody levels using ELISA techniques, and detection of proteins expressed during lymphocyte development using Western blot analyses.

Prerequisite(s): BIOL 437 (may be taken concurrently)*Additional fees apply***BIOL 438 Immunology Lab (1 Credit)**

An introduction to current techniques available to study immune responses in mice. Includes tissue culture of lymphocytes, measuring antibody levels using ELISA techniques, and detection of proteins expressed during lymphocyte development using Western blot analyses.

Prerequisite(s): BIOL 437 (may be taken concurrently)*Additional fees apply***BIOL 442 Molecular Genetics (3 Credits)**

This course gives a comprehensive introduction to molecular genetics emphasizing genome organization, DNA replication and repair, synthesis of RNA and proteins, regulation of prokaryotic and eukaryotic gene expression, epigenetics, RNA processing, molecular genetics of cancer, DNA biotechnology and human gene therapy.

Prerequisite(s): (BIOL 220 or BIOL 204) and (BIOL 225 or BIOL 203)**BIOL 442L Molecular Genetics Lab (1 Credit)**

Experiments illustrating current techniques in molecular genetics, including basic cloning, transformation of bacteria with recombinant DNA, plasmid and genomic DNA purification, gel electrophoresis, restriction digests, DNA labeling, Southern transfer, PCR and green fluorescent protein expression in transfected mammalian cells.

Prerequisite(s): BIOL 442 (may be taken concurrently)*Additional fees apply***BIOL 443 Molecular Gene Lab (1 Credit)**

Experiments illustrating current techniques in molecular genetics, including basic cloning, transformation of bacteria with recombinant DNA, plasmid and genomic DNA purification, gel electrophoresis, restriction digests, DNA labeling, Southern transfer, PCR and green fluorescent protein expression in transfected mammalian cells.

Prerequisite(s): BIOL 442 (may be taken concurrently)*Additional fees apply*

BIOL 444 Mentored Biology Teaching (1 Credit)

Prerequisite(s): Student must have achieved an A- or above in the class in which they will assist, or be otherwise approved to enroll. Instructor permission required. A mentored experience in biology teaching through selected readings and short discussion sessions. Teaching skills will be developed by assisting in approved biology classes. May be repeated for credit with a maximum of 2 credits counted toward requirements for the Biology major. Repeated enrollment in the same course section requires that a student gain additional experiences and teaching skills beyond what was learned while assisting in the prior course section.

BIOL 445 GIS for Biologists (3 Credits)

This hands-on course will integrate Geographical Information Systems into biological research. Emphasis will be on developing spatial metrics, comparing cell or land cover patterns across spatial or temporal scales, classifying satellite or medical imagery, and modeling species distributions.

Prerequisite(s): (BIOL 204 or BIOL 220) and (BIOL 203 or BIOL 225)

BIOL 450 Advanced Research Methods and Experimental Approaches (1 Credit)

Advanced Laboratory courses that provide training in advanced research techniques and often involve multiweek experiments. These labs provide one way to fulfill the 400-level laboratory requirement for biology. Three laboratory hours. There is a fee associated with the laboratory.

Prerequisite(s): BIOL 440 or BIOL 306

Additional fees apply

BIOL 450A Molecular Neuroscience Lab (1 Credit)

An introduction to the use of molecular biology methods in neuroscience such as fluorescent protein expression vector design, basic cloning of plasmid DNA, its purification and expression in cells of the brain so that they can be imaged and analyzed.

Prerequisite(s): BIOL 310 or BIOL 345

Additional fees apply

BIOL 450B Molecular Cell Biology Laboratory (1 Credit)

An introduction to the use of cell biology laboratory techniques including light microscopy, mutant analysis, and selected biochemical techniques.

Prerequisite(s): BIOL 310

Additional fees apply

BIOL 450C Conservation Biology Lab (1 Credit)

This course has two goals. First, students will learn current field techniques to sample local flora and fauna and how to analyze survey and long-term monitoring data sets. Second, students will learn current quantitative approaches in conservation to model connectivity, population viability, and reserve design.

Prerequisite(s): BIOL 318 (may be taken concurrently)

Additional fees apply

BIOL 450D Genomics/Functional Genetics Lab (1 Credit)

Genomics & Functional Genetics Lab. This lab class is designed to provide a foundation in the principles of genomics research and its practical applications. Students will gain a working understanding of bioinformatics tools used to analyze genes and genomes, and learn how model genetic organisms can be used to examine gene function. Credit counts toward Biology major. Fulfills upper level laboratory requirement.

Prerequisite(s): BIOL 306 or BIOL 310 or BIOL 420 or BIOL 433 or BIOL 442

Additional fees apply

BIOL 450E Ecology Lab (1 Credit)

Ecology is the study of interrelationships between species and their environments, from an organismal to ecosystem scale. The Ecology Lab will complement Ecology Lecture topics by providing hands-on experience with ecological research techniques in local habitats (forest, lake, stream, and estuary). Natural history of local flora and fauna will be emphasized.

Prerequisite(s): (BIOL 203 and BIOL 204)

Corequisite(s): BIOL 311

Additional fees apply

BIOL 450F Wild Yeast and Fermentation Lab (1 Credit)

In this lab, students will isolate yeast from the College Woods, using microbiological and genetic tools to determine the species identity of our isolates. Students will then use these *Saccharomyces* isolates to investigate natural variation in fermentation. Instructor permission is required.

Prerequisite(s): BIOL 306 or BIOL 312

Additional fees apply

BIOL 450G Genetic Analysis Laboratory (1 Credit)

Designed to illustrate genetic principles through experimental work with living organisms, and may include yeast, bacteria, fruit flies, and/or nematodes.

Prerequisite(s): BIOL 310 or BIOL 420 or BIOL 442 (may be taken concurrently)

Additional fees apply

BIOL 451 Genomics/Functional Genetics Lab (1 Credit)

Genomics & Functional Genetics Lab. This lab class is designed to provide a foundation in the principles of genomics research and its practical applications. Students will gain a working understanding of bioinformatics tools used to analyze genes and genomes, and learn how model genetic organisms can be used to examine gene function. Credit counts toward Biology major. Fulfills upper level laboratory requirement.

Prerequisite(s): BIOL 306 or BIOL 310 or BIOL 420 or BIOL 433 or BIOL 442

BIOL 453 Protein Structure & Function (3 Credits)

The functionality of a protein is an integral part of its structure. This course provides a comprehensive analysis of how to use sequence data to understand a protein's physical properties, and to predict its function and interaction. Three class hours. Students may not receive credit for more than one of the following: CHEM 415, CHEM 453 and BIOL 453.

Prerequisite(s): BIOL 310 or (BIOL 414 or CHEM 414 or BIOL 314 or CHEM 314)

BIOL 453L Protein Structure and Function Laboratory (2 Credits)

Modern biochemical techniques used by scientists to understand the functionality of proteins, including bacterial transformation, recombinant DNA purification, mammalian transfection, DNA/protein purification, immunoprecipitation, SDS-PAGE, coomassie and silver staining, western blot analysis, fast performance liquid chromatography, and 2-D gel analysis.

Prerequisite(s): BIOL 453 (may be taken concurrently) or CHEM 453 (may be taken concurrently)

Additional fees apply

BIOL 454 Bioinformatics and Molecular Evolution (3 Credits)

An introduction to computational molecular biology and molecular evolution including nucleotide and amino acid sequence comparison, DNA fragment assembly, phylogenetic tree construction and inference, RNA and protein secondary structure prediction and substitution models of sequence evolution.

Prerequisite(s): (MATH 112 or MATH 132) and (BIOL 203)

BIOL 455 How Students Learn (1 Credit)

A practical review of research on the structure and function of brain areas involved in learning (2/3 of the class) followed by practical methods to use this knowledge in teaching at the high school level (1/3 of the class). Not applicable to major or minor, with the exception that students pursuing a career in education may petition to count this toward a Biology major or minor.

BIOL 456 Vertebrate Biology (3 Credits)

A study of the ecology, phylogeny, behavior, physiology and functional morphology of vertebrates, with special emphasis on fishes, amphibians and reptiles.

Prerequisite(s): BIOL 206 or BIOL 302

BIOL 456L Vertebrate Biology Lab (1 Credit)

An overview of select techniques and approaches used by researchers in vertebrate biology, with special emphasis on fishes, amphibians and reptiles. Students will be introduced to facilities available on campus for designing and 3D-printing models and will develop a research project. Three laboratory hours. There is a fee associated with the laboratory.

Prerequisite(s): BIOL 456 (may be taken concurrently)

Additional fees apply

BIOL 457 Marine Invertebrate Biology (4 Credits)

Biology of the major invertebrate groups with an emphasis on marine and estuarine species. Strongly recommended for students interested in marine biology.

Prerequisite(s): BIOL 302

Additional fees apply

BIOL 458 Conservation Biology Laboratory (1 Credit)

This course has two goals. First, students will learn current field techniques to sample local flora and fauna and how to analyze survey and long-term monitoring data sets. Second, students will learn current quantitative approaches in conservation to model connectivity, population viability, and reserve design.

Prerequisite(s): BIOL 318 (may be taken concurrently)

Additional fees apply

BIOL 459 Critiquing Biomedical Assumptions (1 Credit)

A study of cases in which uncritical acceptance of flawed assumptions prevented advances in areas of biology, chemistry, mathematics, and physics broadly related to medicine. Includes reading of primary literature, student presentation, and discussion. Appropriate for juniors and seniors; likely to be of greatest relevance to majors in the natural, physical, or computational sciences interested in biomedical research or clinical practice. One class hour.

BIOL 460 Advanced Seminar in Biology (3 Credits)

Special topics of interest will be discussed within the context of small, advanced seminar courses. Advanced seminars emphasize critical reading of the primary literature and discussions of experimental design. Students will be expected to give one or more oral presentations and complete one or more major writing assignments. Fulfills the major writing requirement in biology. Appropriate for juniors and seniors. With instructor permission, courses with this number may be repeated for credits when the topic varies, however only one counts towards the minimum 37 credits required for the major.

College Curriculum: C400

BIOL 461 Marine Ecology and Conservation (3 Credits)

This field course will provide students with a first-hand introduction to the ecology and conservation biology of intertidal and subtidal ecosystems in the San Juan Archipelago of Washington State. Students are required to present a field lesson and conduct original research. Course meets three times before and after field trip. Field trip is held over spring break (3-credit hours).

Prerequisite(s): (BIOL 220) and BIOL 302

College Curriculum: C400

BIOL 480 Readings in Biology (1-3 Credits)

A directed readings course to investigate the biological basis of an advanced special topic in biology, with intensive reading of review of articles, texts, and primary literature on the topic.

Prerequisite(s): (BIOL 203) and (BIOL 204) or (BIOL 225 and BIOL 220)

BIOL 495 Honors (3 Credits)

Independent laboratory or field research for biology majors under the supervision of a faculty member. Students are required to write an Honors thesis based on a review of the literature and their research. Six hours may be applied toward the minimum 37 required for the biology major.

BIOL 496 Honors (3 Credits)

Independent laboratory or field research for biology majors under the supervision of a faculty member. Students are required to write an Honors thesis based on a review of the literature and their research. Six hours may be applied toward the minimum 37 required for the biology major.

College Curriculum: C400

BIOL 498 Internship in Biology (1-3 Credits)

This course is designed to help students gain knowledge through hands-on experiences in biology within a professional environment including work with companies, government agencies, non-profits, research labs, and other entities where expert supervision in biology-related work can be provided. The academic component of BIOL498 will be overseen by a Biology Faculty Mentor, and the student must complete additional agreed-upon assignments tying their experience to existing theory or research. Requires advanced approval from a Biology Faculty Mentor and Biology Internship Director(s).