

# BIOLOGY (BIOL)

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## **BIOL 101. Biological Concepts. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. A topical approach to basic biological principles. Topics include molecular aspects of cells, bioenergetics, photosynthesis, cellular respiration, cellular and organismal reproduction, genetics and evolution, and ecology. Not applicable for credit toward the major in biology.

## **BIOL 103. Global Environmental Biology. 4 Hours.**

Semester course; 3 lecture and 2 laboratory hours (delivered mostly online). 4 credits. Online presentations, assignments, debates and exams require students to understand situations and ideas that involve scientific, social and economic concepts associated with Earth's environment. Laboratory exercises reinforce major course concepts. Integrates aspects of biology, chemistry, geology, physics and sociology. Topics include ecology, evolution, natural resources, air and water resources, energy and recycling, population biology, and sustainable global societies. Not applicable as a prerequisite for any biology course at the 200 level or above, nor for credit toward the B.S. in Biology.

## **BIOL 151. Introduction to Biological Sciences I. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: MATH 141, MATH 151, MATH 200, MATH 201 or a satisfactory score on the math placement exam; and CHEM 100 with a minimum grade of B, CHEM 101 with a minimum grade of C or a satisfactory score on the chemistry placement exam. Introduction to core biological concepts including cell structure, cellular metabolism, cell division, DNA replication, gene expression and genetics. Designed for biology majors.

## **BIOL 152. Introduction to Biological Sciences II. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 151 and CHEM 101, both with a minimum grade of C. Focuses on evolutionary principles, the role of natural selection in the evolution of life forms, taxonomy and phylogenies, biological diversity in the context of form and function of organisms, and basic principles of ecology. Designed for biology majors.

## **BIOL 200. Quantitative Biology. 3 Hours.**

Semester course; 3 lecture hours (delivered online or hybrid). 3 credits. Prerequisites: BIOL 151 and BIOZ 151 with minimum grades of C; and MATH 151, MATH 200, MATH 201, STAT 210 or satisfactory score on the VCU Mathematics Placement Test within a one-year period immediately preceding the beginning of the course. Enrollment is restricted to biology majors and biology minors. An introduction to the application of the scientific method, experimental design and quantitative aspects of biology.

## **BIOL 201. Human Biology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 101, 151, or 152, or BIOL/ENVS 103. Fundamentals of human biology, including the structure, function and disorders of human body systems, principles of human genetics and inheritance, human evolution, and the interaction of humans with the environment. Not applicable for credit toward the B.S. in Biology.

## **BIOL 205. Basic Human Anatomy. 4 Hours.**

Semester course; 3 lecture and 3 laboratory hours (plus online component). 4 credits. Prerequisites: BIOL 101 and BIOZ 101, BIOL 151 and BIOZ 151, or BIOL 152 and BIOZ 152, each with a minimum grade of C. Enrollment is restricted to students majoring in communication arts, health and physical education, health, physical education and exercise science; pre-health majors in clinical laboratory sciences, clinical radiation sciences, dental hygiene and nursing; students enrolled in the health sciences certificate program; and students in the advising tracks for pre-occupational therapy, pre-physician assistant, pre-pharmacy and pre-physical therapy. Additionally, students in the pre-dentistry and pre-nursing accelerated advising tracks must speak with a pre-professional health adviser prior to enrolling in the class. Human specimens, models and interactive software are used to study human body structures; emphasis is on the skeleto-muscular aspects. Not applicable for credit toward the B.S. in Biology.

## **BIOL 209. Medical Microbiology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 101 and BIOZ 101, BIOL 151 and BIOZ 151, or BIOL 152 and BIOZ 152, each with a minimum grade of C. General principles of microbiology and immunology to provide a thorough understanding of the host-microbe relationship in disease. Not applicable for credit toward the B.S. in Biology.

## **BIOL 217. Principles of Nutrition. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 101, 151 or 152 with a minimum grade of C, or BIOL/ENVS 103 with a minimum grade of C. An introduction to basic principles of nutrition and their application in promoting growth and maintaining health throughout the life cycle. Not applicable for credit toward the B.S. in Biology.

## **BIOL 284. Laboratory Assistant Experience. 0 Hours.**

Semester course; 0 hours. 0 credits. Enrollment is restricted to students with permission of the departmental chair and limited to students for whom a laboratory supervisor has agreed to mentor their laboratory assistantship. Helps facilitate student involvement in research laboratories within the Department of Biology. Students will assist with components of the laboratory's operation and gain experience working in a laboratory setting. Students will gain hands-on experience in performing tasks related to specific research areas based on the laboratory in which they are accepted to work. Graded as pass/fail.

## **BIOL 291. Topics in Biology. 1-4 Hours.**

Semester course; variable hours. Variable credit. Prerequisites: BIOL 151, 152 and BIOZ 151, 152, with minimum grades of C. A study of a selected topic in biology. See the Schedule of Classes for specific topics to be offered each semester and prerequisites.

## **BIOL 300. Cellular and Molecular Biology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 151 and 152; BIOZ 151 or LFSC/BNFO 251; BIOZ 152 or LFSC/BNFO 252; CHEM 101 and CHEZ 101, all with a minimum grade of C; BIOL 200, MATH 200, MATH 201, STAT 210, STAT 212 or STAT 314. Biology majors must have completed BIOL 200. Pre- or corequisites: CHEM 102 and CHEZ 102. A study of the molecular biology of the cell as it relates to gene expression, cell signaling, and cell growth and differentiation.

## **BIOL 303. Microbiology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 300 with a minimum grade of C. The morphological, biochemical, taxonomic, genetic and evolutionary characteristics of microorganisms with a primary focus on bacteria. Focuses on the structural, mechanical and biochemical adaptations employed by microorganisms in their interactions with host cells and substrates.

**BIOL 304. Biology Skills. 2 Hours.**

Semester course; 1 lecture hour (delivered online) and 3 laboratory hours. 2 credits. Prerequisites: BIOL 151 and BIOZ 151 and permission of instructor. This course provides a hands-on experience in laboratory techniques, emphasizes the development of library and informational fluency skills, and uses current biological and/or biomedical research topics to aid in development of critical-thinking and problem-solving skills.

**BIOL 307. Aquatic Ecology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 317, CHEM 102 and CHEZ 102, with minimum grades of C. The physical, chemical and especially the biological aspects of freshwater ecosystems.

**BIOL 308. Vertebrate Histology. 4 Hours.**

Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisite: BIOL 300 with a minimum grade of C. Microanatomy of vertebrate cells, tissues and organs and the relationship of structure to function. Laboratory work involves an in-depth study of vertebrate microanatomy at the light microscope level as well as an introduction to techniques used for the preparation of materials for histological study.

**BIOL 309. Entomology. 4 Hours.**

Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisites: BIOL 151, 152 and BIOZ 151, 152, with minimum grades of C. A field-based course that focuses on insect diversification, identification, natural history and basic biology.

**BIOL 310. Genetics. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 151 and 152; BIOZ 151 or LFSC/BNFO 251; BIOZ 152 or LFSC/BNFO 252; BIOL 300; CHEM 101; and CHEZ 101, each with a minimum grade of C; and BIOL 200, MATH 200, MATH 201, STAT 210, STAT 212 or STAT 314. Biology majors must have completed BIOL 200. Pre- or corequisites: CHEM 102 and CHEZ 102. The basic principles of molecular and applied genetics of plants, animals and microorganisms.

**BIOL 312. Invertebrate Zoology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 151, 152 and BIOZ 151, 152, with minimum grades of C. A survey of the invertebrate animals with emphasis on environmental interactions. A weekend trip to a marine environment is required.

**BIOL 313. Vertebrate Natural History. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 151, 152 and BIOZ 151, 152, with minimum grades of C. The natural history of vertebrates with emphasis on the species native to Virginia.

**BIOL 314. Animal Reproduction. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL and BIOZ 151, BIOL and BIOZ 152, and BIOL 300, each with a minimum grade of C. Introduction to basic reproductive anatomy and physiology. Examination of the basic factors that affect reproductive performance and how these factors are used to regulate the reproductive processes of domestic animals and humans.

**BIOL 317. Ecology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 151 and 152; BIOZ 151 or LFSC/BNFO 251; BIOZ 152 or LFSC/BNFO 252; CHEM 101 and CHEZ 101, all with a minimum grade of C; BIOL 200, MATH 200, MATH 201, STAT 210, STAT 212 or STAT 314. Biology majors must have completed BIOL 200. An introduction to the basic principles of ecology, including interactions among organisms and influences of the physical environment.

**BIOL 318. Evolution. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 151 and 152; BIOZ 151 or LFSC/BNFO 251; BIOZ 152 or LFSC/BNFO 252; CHEM 101 and CHEZ 101, all with a minimum grade of C; BIOL 200, MATH 200, MATH 201, STAT 210, STAT 212 or STAT 314. Biology majors must have completed BIOL 200. An exploration of the theoretical and empirical foundations of evolutionary biology with a focus on the processes driving evolutionary change across all of life.

**BIOL 320. Biology of the Seed Plant. 4 Hours.**

Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisites: BIOL and BIOZ 151 and BIOL and BIOZ 152, each with a minimum grade of C. The physiology, structure and adaptation of seed plants.

**BIOL 321. Plant Development. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 300 and 310, each with a minimum grade of C. A survey of the developmental changes that take place during the life cycle of lower and higher plants. Emphasis is placed on the control factors that are involved in regulating the ordered changes which take place during development.

**BIOL 322. Economic Botany. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 151 and 152 and BIOZ 151 and 152, or equivalents, with minimum grades of C. This class focuses on plant morphology, anatomy, phytochemistry, growth and reproduction through an examination of the biology of economically and culturally important plants, including crops used for foods and beverages, medicines and drugs, fibers, and timber.

**BIOL 324. Medicinal Botany. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 151 and BIOZ 151; BIOL 152 and BIOZ 152; and BIOL 300, all with a minimum grade of C. Topics include plant anatomy, morphology and reproduction; traditional plant medicine such as Ayurveda and traditional Chinese medicine; plant defense systems and secondary metabolites; and plant-derived drugs for various illnesses/ailments including cancer, arthritis, depression and diabetes.

**BIOL 325. Fungal Biology. 3 Hours.**

Semester course; 2 lecture and 3 laboratory hours. 3 credits. Prerequisite: BIOL 300 with a minimum grade of C. The basic biology of fungi, including growth, structure, genetics, diversity, the commercial uses of fungi and their importance as model organisms. Also discusses the interactions between fungi and plants and fungi and humans.

**BIOL 332. Environmental Pollution. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: eight credits in biology. The study of pollution in the environment with emphasis on the procedures for detection and abatement. Crosslisted as: ENVS 330.

**BIOL 333. Evolution of the Angiosperms. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 151, 152 and BIOZ 151, 152, all with minimum grade of C. Application of evolutionary concepts to flowering plants. Topics include speciation concepts, evolution of vegetative and sexual characteristics and an overview of angiosperm diversity to the level of family.

**BIOL 335. Global Change Biology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 151, BIOL 152, BIOZ 151 and BIOZ 152, all with minimum grade of C. Examines how humans influence biological systems and explores what can be done to adapt to or to mitigate future global change, emphasizing anthropogenic climate change.

**BIOL 340. Development and Stem Cells. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 300 and CHEM 102, each with a minimum grade of C. Basic principles of developmental biology and stem cells of vertebrates, pinpointing the underlying cellular and molecular mechanisms that guide development and stem cell biology. Significant emphasis on medical aspects of development such as human birth defects, cloning, properties of stem cells and their medical uses, and careers in developmental and stem cell biology.

**BIOL 341. Human Evolution. 4 Hours.**

Semester course; 3 lecture and 2 laboratory hours. 4 credits. Prerequisite: UNIV 200 or HONR 200 with a minimum grade of C. Introduces the range of human diversity as well as a broad understanding of evolution and evolutionary biology, particularly as it applies to hominid evolution. Specific topics include basic genetics, primatology, paleontology and the hominin fossil record. Crosslisted as: ANTH 301.

**BIOL 351. Introduction to Bioinformatics. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BNFO 201 and BNFO 300 or permission of instructor. The course will present a practical and theoretical introduction to the tools and techniques needed to obtain and interpret a variety of genome-related data types. The course will include several bioinformatic methods underlying nucleotide and protein sequence alignment, statistical methods for data visualization in R, the types of experimental results commonly encountered in bioinformatics data analysis and the public databases where these data can be accessed. Crosslisted as: BNFO 301.

**BIOL 391. Topics in Biology. 1-4 Hours.**

Semester course; 1-4 lecture hours. 1-4 credits. Prerequisites: BIOL 152 and BIOZ 152; and BIOL 300, BIOL 310, BIOL 317 or BIOL 318, each with a minimum grade of C. A study of a selected topic in biology. See the Schedule of Classes for specific topics to be offered each semester and prerequisites.

**BIOL 392. Introduction to Research. 2 Hours.**

Semester course; 1 lecture and 1 demonstration hour. 2 credits. Prerequisite: BIOL 300, BIOL 310, BIOL 317 or BIOL 318 with a minimum grade of C. An introduction to the scientific process, including the mechanics of problem definition, information gathering and experimental design. Experimentation is discussed in context with methods of data collection and analysis. Aims are to prepare the student for future research experiences and to have the student write detailed research proposals.

**BIOL 395. Directed Study. 1-2 Hours.**

Semester course; 1-2 independent study hours. 1-2 credits. Prerequisites: BIOZ 151 and BIOZ 152 with minimum grades of C, permission of the Department of Biology and research mentor. A maximum of two credits may be earned between BIOL 395 and BIOZ 395; maximum total of six credits for all research and internship courses (BIOL 395, BIOL 451, BIOL 453, BIOL 492, BIOL 493, BIOL 495 and/or BIOZ 395) may be applied to the the 40 credits of biology required for the major. Additional credits from these courses may be applied to upper-level and open elective credits toward the degree. Mentors are not limited to faculty members within the Department of Biology, but the context of the research study must be applicable to the biological sciences as determined by the department. Studies should include directed readings, directed experimentation or advanced guided inquiry — all under the direct supervision of a faculty member. A minimum of three hours of supervised activity per week per credit hour is required. This course may not apply as a laboratory experience. Graded as pass/fail.

**BIOL 401. Applied and Environmental Microbiology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: 300 and 317, each with a minimum grade of C. The biology and chemical activities of microorganisms (bacteria, algae, virus and fungi) of industrial, pharmaceutical and agricultural importance.

**BIOL 402. Comparative Vertebrate Anatomy. 5 Hours.**

Semester course; 3 lecture and 4 laboratory hours. 5 credits. Prerequisites: BIOL 300 and BIOL 318, each with a minimum grade of C. The evolution of vertebrate forms as demonstrated by anatomical studies of selected vertebrate types.

**BIOL 403. Primatology. 4 Hours.**

Semester course; 3 lecture and 2 laboratory hours. 4 credits. Prerequisite: ANTH 210 or ANTH 301/BIOL 341. Primatology investigates the taxonomic relationships among primates through comparative anatomy, comparative behavior and comparative biochemistry. Study of primate evolution, demography, subsistence, reproduction, social organization, communication systems and ecology. Crosslisted as: ANTH 403.

**BIOL 411. Physiology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 300 and CHEM 301, each with a minimum grade of C. Focuses on the characterization and understanding of the function and mechanisms of major physiological systems, primarily using human physiology as a model. Emphasis is placed on understanding how different physiological systems work together to maintain homeostasis and predicting the consequences of damaging or deleting system components that can occur in diseases and injuries.

**BIOL 413. Parasitology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 300 with a minimum grade of C. The epidemiology and pathological effects of eukaryotic parasites, including parasite life cycles and host-parasite relationships.

**BIOL 415. Mangrove Avian Field Ecology. 4 Hours.**

Semester course; two weeks abroad in Panama (or other tropical location with mangrove forests) followed by class meetings two days per week throughout most of spring semester. 4 credits. Prerequisite: BIOL 317. An immersive study of tropical ecology with a focus on bird ecology and conservation of mangrove ecosystems through a unique blend of rigorous science and community engagement. Two weeks of study abroad, including engagement with local conservation organizations and participation in education outreach with local schools, followed by discussion, data analysis and presentation of progress and research in a public symposium on campus.

**BIOL 416. Ornithology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 317 with a minimum grade of C. Provides an integrative study of birds, including avian evolution and diversity, general anatomy and physiology, behavior, and ecology.

**BIOL 417. Mammalogy. 4 Hours.**

Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisites: BIOL 218 and 317 with minimum grades of C. Study of the characteristics, adaptive radiation and distribution of mammals, with emphasis on North American forms.

**BIOL 420. Yeast and Fermentation. 3 Hours.**

Semester course; 2 lecture and 3 laboratory hours. 3 credits. Prerequisite: BIOL 300 with a minimum grade of C. Corequisites: BIOL 303 and BIOL 310. Addresses the basic biology of yeast used in brewing beer and briefly in wine production. Topics will include yeast properties such as growth, structure, genetics, biodiversity and natural habitats. The process of wine and beer production will be discussed. Laboratory sessions include basic microbiology techniques, yeast isolations and characterization using DNA and biochemical methods, as well as the study of factors that affect fermentation. At the end of the course the students will give a presentation on other fermentation products of their interest such as vinegar, bread, etc., providing an expanded version of this important process.

**BIOL 422. Forest Ecology. 4 Hours.**

Semester course; 3 lecture hours and 3 laboratory hours. 4 credits. Prerequisite: BIOL 317 with a minimum grade of C. Covers the fundamentals of forest ecology, with a particular emphasis on Virginia's diverse forest ecosystems. Students gain an understanding of the principal controls on forest structure, growth and distribution and relate these principles to sustainable forest management.

**BIOL 423. Plant Physiology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 151 and BIOZ 151; BIOL 152 and BIOZ 152; and BIOL 300 or equivalents, all with minimum grades of C. Physiology of higher plants at molecular, cellular and organism level. Topics include transport processes, metabolism, growth, stress responses and plant-soil interactions.

**BIOL 425. Field Botany. 3 Hours.**

Semester course; 2 lecture hours and 3 laboratory hours. (60 percent online, 40 percent field/laboratory) 3 credits. Prerequisites: BIOL 310 and BIOL 317, both with minimum grades of C. Online lectures, discussions, reflections and assessments in conjunction with field experience. Explores the effects of environmental conditions on plant morphology and adaptations, with emphasis on plant anatomy, plant physiology and ecology.

**BIOL 430. Invasion Biology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 151, BIOL 152, BIOZ 151, BIOZ 152 and BIOL 317, all with minimum grade of C. A comprehensive view of the ecology and impacts of invasive species. Integrates the effects of historical human demography, ecological disturbance, natural history, species interactions, barriers to invasion, invasive species management and impacts on natural communities and ecosystems.

**BIOL 431. Introduction to Marine Biology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 317, CHEM 102 and CHEZ 102, with minimum grades of C. An introduction to physical, chemical and geological oceanography and a more detailed treatment of the organisms and ecological processes involved in the pelagic and benthic environments of the world's oceans and estuaries.

**BIOL 435. Herpetology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 317 with a minimum grade of C. The evolution, ecology, structure, taxonomy and behavior of reptiles and amphibians.

**BIOL 438. Forensic Molecular Biology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 310 with a minimum grade of C. Provides an understanding of molecular biology testing methodologies as applied to analysis of forensic samples. Current topics in forensic DNA analysis will include quality assurance, DNA databanking, contemporary research and population genetics. Crosslisted as: FRSC 438.

**BIOL 440. Developmental Biology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 300 and 310, each with a minimum grade of C. Basic principles of developmental biology focused on vertebrate model organisms with an emphasis on the underlying cellular and molecular mechanisms that guide development.

**BIOL 445. Neurobiology and Behavior. 4 Hours.**

Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisite: BIOL 317 with a minimum grade of C. The study of animal behavior stressing ecological, evolutionary and neurobiological approaches.

**BIOL 448. Neuroscience. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 300 with a minimum grade of C. Pre- or corequisite: BIOL 310. An examination of the basic structure of the nervous system, nervous system operation on a cellular and molecular level and the formation of the nervous system during development.

**BIOL 450. Biology of Cancer I. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 300 with a minimum grade of C or PHIS 309. An examination of the cellular, molecular and clinical aspects of cancer development, progression and treatment.

**BIOL 451. Biology of Cancer II. 4 Hours.**

Semester course; 1 lecture and 12 laboratory hours. 4 credits. Prerequisites: BIOL 450 and instructor's permission. A maximum total of six credits for all research and internship courses (BIOL 395, BIOL 451, BIOL 453, BIOL 492, BIOL 493, BIOL 495 and/or BIOZ 395) may be applied to the the 40 credits of biology required for the major. Additional credits from these courses may be applied to upper-level and open elective credits toward the degree. An examination of the cellular, molecular and clinical aspects of cancer development, progression and treatment.

**BIOL 452. Biology of Drugs. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 300 with a minimum grade of C. Explores how drugs modulate biological signaling pathways to study, cure, enhance and intoxicate organisms. An introduction to basic pharmacology that largely focuses on human pathways and diseases. Topics include major drug classes (cardiovascular, gastrointestinal, etc.) and drugs of abuse (alcohol, marijuana, etc.).

**BIOL 453. Cancer Biology Thesis. 4 Hours.**

Semester course; 1 recitation and 12 laboratory hours. 4 credits. Prerequisite: BIOL 451. A maximum total of six credits for all research and internship courses (BIOL 395, BIOL 451, BIOL 453, BIOL 492, BIOL 493, BIOL 495 and/or BIOZ 395) may be applied to the the 40 credits of biology required for the major. Additional credits from these courses may be applied to upper-level and open elective credits toward the degree. Enrollment is restricted to students with permission of the instructor and research mentor. Students will benefit from invaluable learning opportunities in cancer research including hands-on learning, direct mentorship from a VCU faculty member, scientific writing skills, time and research project management, and exposure to and training in various laboratory techniques. In addition, students will gain experience in preparation of a cancer research proposal and thesis.

**BIOL 455. Immunology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 300 with a minimum grade of C or PHIS 309. A comprehensive introduction to the immune system of higher animals, emphasizing the molecular and cellular basis for antibody-mediated immunity.

**BIOL 459. Infectious Disease Ecology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 151, BIOL 152, BIOZ 151, BIOZ 152 and BIOL 317, all with minimum grade of C. A comprehensive and up-to-date overview of the causes and consequences of infectious disease at levels from individual organisms to global scale. Examines the history of infectious disease ecology in human and nonhuman populations. Students learn about the roles of transmission and coevolution in infectious disease ecology and how population models are used to inform management of epidemics and emerging infectious diseases.

**BIOL 460. Human Evolutionary Genetics. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 318 or BIOL 341 with a minimum grade of C. The origin and genetic history of modern humans, our historic colonization and migration, the utility of the Human Genome Project, our differences from other primates, adaptation to our environment and disease, and the ethical implications of genetic research in our society.

**BIOL 475. Biology Capstone Seminar. \_\_\_\_\_. 1-3 Hours.**

Semester course; 1-3 seminar hours. 1-3 credits. Prerequisites: BIOL 300, BIOL 310, BIOL 317 and BIOL 318, each with a minimum grade of C. Enrollment is restricted to biology majors with senior standing. Students read assigned topical papers before class, prepare critical analyses, discuss and debate selected positions. See Schedule of Classes for specific topics.

**BIOL 477. Biology Capstone Experience. 0 Hours.**

Semester course; variable hours. 0 credits. Prerequisites: BIOL 300, BIOL 310, BIOL 317 and BIOL 318, each with a minimum grade of C; and 90 hours of undergraduate course work. The following courses qualify as a capstone experience if taken concurrently with this course: BIOL 492, BIOL 493, BIOL 495, BIOL 497 or other courses, including topics courses, which include the core competencies required for a capstone experience and are approved by the chair of the Department of Biology. Graded as pass/fail.

**BIOL 480. Animal-Plant Interactions. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 317 or BIOL 318 with a minimum grade of C, or permission of the instructor. Ecological and evolutionary consequences of interactions among animals and plants.

**BIOL 482. Preceptor Experience. 0 Hours.**

Semester course; 0 hours. 0 credits. Enrollment is restricted to students who have completed the relevant course for which they will be a teaching assistant with a minimum grade of B and who have a minimum cumulative GPA of 3.0. Permission of instructor and departmental chair also required prior to registration. Teaching assistants will enhance their knowledge of course content and develop skills that are natural to an instructional role, an understanding of the learning process within a discipline and the ability to explain the importance and value of course content to a novice audience. Graded as pass/fail.

**BIOL 484. Research Assistant Experience. 0 Hours.**

Semester course; 0 hours. 0 credits. Enrollment is restricted to students with permission of the departmental chair and limited to students for whom a research supervisor has agreed to be a mentor. Helps facilitate student involvement in research laboratories within the Department of Biology. Students will gain hands-on experience including data collection and analysis, learning field and/or laboratory techniques, and/or mastering experimental procedures, all under the direct supervision of a faculty member. Graded as pass/fail.

**BIOL 489. Communicating Research. 1 Hour.**

Semester course; 1 lecture hour. 1 credit. Prerequisite: Completion of the Biocore with minimum grades of C. Corequisite: BIOL 495, senior standing. An opportunity for students to develop skills necessary for effective communication of their research in writing. Includes a variety of seminar discussions and activities including preparation of figures for publication and the crafting of a research paper with correct usage of the primary literature. Students will use this as an opportunity to aid the writing of their thesis for BIOL 495.

**BIOL 490. Presenting Research. 1 Hour.**

Semester course; 1 credit. Prerequisite: Completion of the Biocore with minimum grades of C. Pre- or corequisites: BIOL 492 or 495, and senior standing. Opportunity for students to develop skills necessary for effective oral presentation of their research work. Includes a variety of seminar discussions and activities such as preparation of visual materials and statistical analysis of data. Students will make several oral presentations directly related to their specific BIOL 492 or 495 projects.

**BIOL 491. Topics in Biology. 1-4 Hours.**

Semester course; variable hours. Variable credit. Prerequisite: BIOL 300. A study of a selected topic in biology. See the Schedule of Classes for specific topics to be offered each semester and prerequisites.

**BIOL 492. Independent Study. 1-4 Hours.**

Semester course; 1-4 independent study hours. 1-4 credits. Prerequisites: BIOZ 151 and BIOZ 152, each with a minimum grade of C; and permission of the chair of the Department of Biology. May be repeated for credit. A maximum total of six credits for all research and internship courses (BIOL 395, BIOL 451, BIOL 453, BIOL 492, BIOL 493, BIOL 495 and/or BIOZ 395) may be applied to the 40 credits of biology required for the major. Additional credits from these courses may be applied to upper-level and open elective credits toward the degree. A minimum of two credits is required for the course to count as a laboratory experience. Projects should include data collection and analysis, learning field and/or laboratory techniques, and/or mastering experimental procedures, all under the direct supervision of a faculty member. A minimum of three hours of supervised activity per week per credit hour is required. A final report must be submitted at the completion of the project.

**BIOL 493. Biology Internship. 1-3 Hours.**

Semester course; 1-3 field experience hours. 1-3 credits. Prerequisites: BIOL 310 or 317 with minimum grades of C; and permission of the chair of the Department of Biology and of the agency, company or organization in which internship will be held. May be repeated for credit. Students may take a maximum of three credits per semester; maximum total of six credits for all research and internship courses (BIOL 395, BIOL 451, BIOL 453, BIOL 492, BIOL 493, BIOL 495 and/or BIOZ 395) may be applied to the 40 credits of biology required for the major. Additional credits from these courses may be applied to upper-level and open elective credits toward the degree. One credit is awarded for each 100 hours of work experience in professional biology setting. Internship designed to provide laboratory or field experience in an off-campus professional biology setting. A final report must be submitted upon completion of the internship. Graded as pass/fail.

**BIOL 495. Research and Thesis. 1-4 Hours.**

Semester course; 1-4 research hours. 1-4 credits. Prerequisites: BIOL 392, permission of the supervising faculty member and a research proposal acceptable to the departmental chair. Corequisite: BIOL 489 or BIOL 490. May be repeated for a maximum of eight credits. Students may take a maximum of four credits per semester; maximum total of six credits for all research and internship courses (BIOL 395, BIOL 451, BIOL 453, BIOL 492, BIOL 493, BIOL 495 and/or BIOZ 395) may be applied to the 40 credits of biology required for the major. Additional credits from these courses may be applied to upper-level and open elective credits toward the degree. A minimum of two credits is required for the course to count as a laboratory experience. A minimum of four credits is required for honors in biology. Activities include field and/or laboratory research under the direct supervision of a faculty mentor. A minimum of three hours of supervised activity per week per credit hour is required. Research projects must include experimental design and analysis of data. This course must be taken for two consecutive semesters starting in the fall. A written thesis of substantial quality is required upon completion of the research.

**BIOL 496. Biology Preceptorship: \_\_\_\_\_. 2 Hours.**

Semester course; 2 practicum hours. 2 credits. May be repeated with a different course for credit. Enrollment restricted to students who have completed the relevant course with a minimum grade of B and who have a minimum cumulative GPA of 3.0. Permission of instructor is required prior to registration. Preceptors assist instructors in lecture (BIOL) or laboratory (BIOZ) courses. Responsibilities vary and may include, but are not limited to, attending class, conducting review sessions and preparing course study/review materials. Graded as pass/fail. A maximum of four combined credits from BIOL 496 and BIOL 499 may be applied to degree requirements.

**BIOL 497. Ecological Service Learning. 1 Hour.**

Semester course; 1 lecture hour. 1 credit. Prerequisite: BIOL 317 with a minimum grade of C. A service-learning course coupled to course content and material taught in BIOL 317. Students will seek out ecologically relevant opportunities with local, state and federal community partners who will provide experiences to enhance academic enrichment and personal growth and will help foster a sense of civic responsibility. Students must complete a minimum of 20 service-learning hours with community partner(s).

**BIOL 498. Insects and Plants Service-learning. 2 Hours.**

Semester course; 2 field experience hours. 2 credits. Prerequisites: BIOL 317 or BIOL 318 with a minimum grade of C, and permission of the instructor. A service-learning course related to insect-plant interactions. Field experience with community partners, including public parks, botanical gardens and organic farms. Designed to expand academic instruction, enhance personal growth and foster a sense of civic responsibility. Students must complete a minimum of 40 service-learning hours with a community partner.

**BIOL 499. Biology Lead Preceptorship. 2 Hours.**

Semester course; 2 practicum hours. 2 credits. Prerequisite: BIOL 496 in the same course with a grade of Pass. Enrollment is restricted to students who have completed the relevant course with a minimum grade of B and who have a minimum cumulative GPA of 3.0. Permission of the instructor is required prior to registration. Lead preceptors assist instructors in lecture (BIOL) or laboratory (BIOZ) courses. Responsibilities cumulate beyond those required in the prerequisite course. Responsibilities vary and may include, but are not limited to, organizing preceptor teams for large enrollment courses, preceptor mentorship, data entry of course materials, execution of group work, etc. Graded as pass/fail. A maximum of four combined credits from BIOL 496 and BIOL 499 may be applied to degree requirements.

**BIOL 502. Microbial Biotechnology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: MICR/ BIOC 503 or BIOC 530, 531, 532 and 533 or equivalent, and MICR/ BIOC 504 or equivalent. Open to qualified seniors and graduate students only. Discussion of the application of basic principles to the solution of commercial problems. The course will cover the historical principles in biotransformations as related to primary and secondary metabolism, as well as recombinant DNA technology and monoclonal antibodies and products resulting from the application of recombinant DNA technology.

**BIOL 503. Fish Biology. 4 Hours.**

Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisite: BIOL 317 or equivalent. Open to qualified seniors and graduate students only. Classification, behavior, physiology and ecology of fishes. Laboratories will emphasize field collection of fish and identification of specimens.

**BIOL 507. Aquatic Microbiology. 4 Hours.**

Semester course; 2 lecture and 4 laboratory hours. 4 credits. Prerequisites: BIOL 303 and 307 or equivalents. Open to qualified seniors and graduate students only. This course will involve a practical approach to the methods used to culture, identify and enumerate specific microorganisms that affect the cycling of elements in aquatic systems and those that affect or indicate water quality.

**BIOL 508. Barrier Island Ecology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 317 or equivalent, or permission of instructor. A study of the physical factors affecting the formation of barrier islands, adaptations of plants and animals for colonization and persistence in these harsh environments, and how coastal ecological processes conform to general ecological theory. Examples and problems pertaining to Virginia and the southeastern United States are emphasized.

**BIOL 509. Microbial Ecology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 317 or equivalent with a grade of C or better. Open only to qualified seniors and graduate students. Explores the interactions of microorganisms and their environment, including discussion of microbial diversity, nutrient cycling, symbiosis and selected aspects of applied microbiology.

**BIOL 510. Conservation Biology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Open to qualified seniors and graduate students only. Explores the accelerated loss of species due to increasing human population pressure and the biological, social and legal processes involved in conserving biodiversity.

**BIOL 512. Plant Diversity and Evolution. 4 Hours.**

Semester course; 3 lecture and 4 laboratory hours. 4 credits. Prerequisites: BIOL 300 and 310 or equivalents, or permission of instructor. Taxonomy, diversity and evolutionary history of vascular plants (including ferns, gymnosperms and flowering plants). Lecture emphasis on evolutionary relationships; laboratory emphasis on plant recognition and identification, especially of the Virginia flora, including some field trips to areas of local botanical interest.

**BIOL 514. Stream Ecology. 4 Hours.**

Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisite: BIOL 317. Open to qualified seniors and graduate students only. A study of the ecology of streams and rivers. Laboratory emphasis is on the structure and functioning of aquatic communities in mountain to coastal streams.

**BIOL 516. Population Genetics. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: STAT/BIOS 543. Theoretical and empirical analyses of how demographic and evolutionary processes influence neutral and adaptive genetic variation within populations.

**BIOL 518. Plant Ecology. 4 Hours.**

Semester course; 3 lecture and 2 laboratory hours. One three-day field trip is required. 4 credits. Prerequisite: BIOL 317. Open to qualified seniors and graduate students only. A lecture, field and laboratory course concerned with the development, succession and dynamics of plant communities and their interrelations with climate, soil, biotic and historic factors.

**BIOL 519. Forest Ecology. 4 Hours.**

Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisite: BIOL 317 or equivalent. Enrollment restricted to graduate students and upper-level undergraduates. Covers advanced topics in forest ecology, with a particular emphasis on Virginia's diverse forest ecosystems. Students gain an understanding of the principal controls on forest structure, growth and distribution and apply these principles to the development and execution of a graduate-level field research project.

**BIOL 520. Population Ecology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 310 and BIOL 317 or permission of instructor. Open to qualified seniors and graduate students only. Theoretical and empirical analysis of processes that occur within natural populations, including population genetics, population growth and fluctuation, demography, evolution of life history strategies and interspecific interactions. Quantitative models will be used extensively to explore ecological concepts.

**BIOL 521. Community Ecology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 317 or equivalent. Open to qualified seniors and graduate students only. Theoretical and empirical analysis of the structure and function of natural communities, ecosystems and landscapes.

**BIOL 522. Evolution and Speciation. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 310 or equivalent. Open to qualified seniors and graduate students only. Evolutionary principles, with emphasis on genetic and environmental factors leading to changes in large and small populations of plants and animals, and the mechanisms responsible for speciation.

**BIOL 524. Endocrinology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 300 and CHEM 301-302 and CHEZ 301L, 302L or equivalent. Open to qualified seniors and graduate students only. Hormonal control systems at the organ, tissue and cellular level. Although the major emphasis will be on vertebrate endocrine systems, some discussion of invertebrate and plant control systems will be covered.

**BIOL 530. Introduction to Human Genetics. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Enrollment restricted to qualified seniors and graduate students. Basic knowledge of genetics is recommended. Provides a comprehensive examination of the fundamentals of human genetics. Explores topics including Mendelian and non-Mendelian inheritance, pedigree analysis, cytogenetics, aneuploid syndromes, cancer, gene structure and function, epigenetics, gene expression, biochemical genetics, and inborn errors of metabolism.

**BIOL 535. Wetlands Ecology. 4 Hours.**

Semester course; 3 lecture and 3 laboratory hours. 4 credits. Prerequisite: BIOL 317 or equivalent or permission of instructor. A study of the ecology of freshwater and coastal wetlands, including the physical and biological aspects of these systems, wetland functions at local, landscape and global scales, and wetland regulations and restoration. Students will acquire skills with analytical techniques used in laboratory settings and in field-based applications for purposes of identifying and delineating wetland ecosystems.

**BIOL 540. Fundamentals of Molecular Genetics. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 310 or consent of instructor. The basic principles and methodologies of molecular biology and genetics are applied to genome organization, replication, expression, regulation, mutation and reorganization. Emphasis will be placed on a broad introduction to and integration of important topics in prokaryotic and eukaryotic systems. Crosslisted as: BNFO 540.

**BIOL 541. Laboratory in Molecular Genetics. 2 Hours.**

Semester course; 1 lecture and 4 laboratory hours. 2 credits. Pre- or corequisite: BIOL 540 or equivalent. Experiments are designed to apply advanced techniques and concepts of molecular biology and genetics using prokaryotic and eukaryotic systems. Emphasis will be placed on experimental design, integrating results throughout the semester, making use of relevant published literature, scientific writing and providing hands-on experience with advanced equipment and methodologies. Crosslisted as: BNFO 541.

**BIOL 545. Biological Complexity. 3 Hours.**

Semester course; 2 lecture and 2 laboratory hours. 3 credits. Prerequisites: physics and calculus, or permission of instructor. Open only to graduate students and qualified seniors. An introduction to the basis of complexity theory and the principles of emergent properties within the context of integrative life sciences. The dynamic interactions among biological, physical and social components of systems are emphasized, ranging from the molecular to ecosystem level. Modeling and simulation methods for investigating biological complexity are illustrated. Crosslisted as: LFSC 510.

**BIOL 548. Bioinformatic Technologies. 2 Hours.**

Semester course; 2 lecture hours. 2 credits. Prerequisite: BIOL 545/ LFSC 510 or permission of instructor. Introduction to the hardware and software used in computational biology, proteomics, genomics, ecoinformatics and other areas of data analysis in the life sciences. The course also will introduce students to data mining, the use of databases, meta-data analysis and techniques to access information. Crosslisted as: LFSC 520.

**BIOL 550. Ecological Genetics. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Open to qualified seniors and graduate students only. Introduces the principles of ecological genetics, especially those with foundations in population and quantitative genetics, and illustrates conceptual difficulties encountered by resource stewards who wish to apply genetic principles. Explores various types of biological technologies employed by conservation geneticists and provides means for students to gain experience in analyzing and interpreting ecological genetic data.

**BIOL 560. Conservation Medicine. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Introduces students to key elements of wildlife diseases, zoonoses, emerging infectious diseases associated with wildlife and humans, and both the conservation and health impacts of these topics. Included are discussions of the interactions among environmental quality and wildlife and human diseases and health. Topics include diseases of fish, amphibians, reptiles, birds and mammals, the effects of environmental contaminants and climate on those diseases, and their interaction with human health.

**BIOL 565. Advances in Cell Signaling. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 300 or equivalent. Topical course focusing on advances in cellular communication by cytokines, hormones and neurotransmitters. Each semester, the course focuses on a different topic. Past topics have included cancer biology, allergy and asthma, and autoimmunity.

**BIOL 580. Eukaryotic Biotechnology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisites: BIOL 300 and BIOL 310, both with a minimum grade of C, or graduate standing in biology or a related field. Enrollment is restricted to graduate students and senior undergraduates. Discussion of principles, concepts, techniques, applications and current advances in cellular and molecular biology aspects of biotechnology for animal and plant cells. The course will cover molecular construction of foreign genes; DNA cloning; technologies for DNA, RNA and protein analyses; nonvector and vector-mediated genetic transformation; gene regulation in transgenic cells; cell and tissue culture; cell fusion; and agricultural, medical and other industrial applications.

**BIOL 591. Special Topics in Biology. 1-4 Hours.**

Semester course; 1-4 credits. An in-depth study of a selected topic in biology. See the Schedule of Classes for specific topics to be offered each semester and prerequisites. If several topics are offered, students may elect to take more than one.

**BIOL 601. Integrated Bioinformatics. 4 Hours.**

Semester course; 3 lecture and 3 laboratory hours. 4 credits. Enrollment requires permission of instructor. Presents major concepts in bioinformatics through a series of real-life problems to be solved by students. Problems addressed will include but not be limited to issues in genomic analysis, statistical analysis and modeling of complex biological phenomena. Emphasis will be placed on attaining a deep understanding of a few widely used tools of bioinformatics. Crosslisted as: BNFO 601.

**BIOL 602. Professional and Career Development in Biology. 1 Hour.**

Semester course; 1 lecture hour. 1 credit. Enrollment is restricted to students with graduate standing. This course will equip students early in their graduate experience with the knowledge, resources and skills to rapidly and successfully complete the requirements for an M.S. in Biology while enhancing their communication and planning skills in several critical formats and areas, as well as exploring alternative career paths based on their personal goals and values.

**BIOL 603. Fundamentals of Scientific Leadership. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Enrollment restricted to students with graduate standing. The purpose of this course is to prepare students to successfully work as members and leaders of diverse scientific teams during their graduate studies and in multiple scientific career paths. Students will be familiarized and gain experience with key concepts of teams and leading teams, including values-based missions and goals, effective communication and feedback, stages of team development and leadership, diversity and inclusivity, mentoring and coaching, resolving conflict, project management, leading change, leaving a legacy, and assessment.

**BIOL 604. Research Integrity. 1 Hour.**

Semester course; 1 lecture hour. 1 credit. Enrollment is restricted to students with graduate standing. This course is designed to provide a discussion-based approach to research integrity. By the end of the course students will be acutely aware of how science interacts with and informs society. They will have digested an array of topical issues relating to responsible conduct of research and be able to clearly articulate ethical and legal solutions to problems posed. This course addresses issues across a broad biosciences background including laboratory and field studies. This course targets master's- and entry-level Ph.D. students. Graded as pass/fail.

**BIOL 605. Diversity and Inclusion in Science. 1 Hour.**

Semester course; 1 lecture hour. 1 credit. Enrollment is restricted to students with graduate standing. This course will familiarize and engage students with multiple forms of diversity in science through presentations, diverse guest speakers, class discussions and student assignments, preparing them to recognize and leverage this diversity by employing inclusiveness throughout their scientific careers and lives.

**BIOL 606. Quantitative Ecology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Principles and applications of mathematical ecology at the community level, including experimental design; sampling techniques, assumptions and limitations; and the use of cluster analysis, gradient analysis and ordination to evaluate, summarize and compare large data sets.

**BIOL 607. Science Communication: Fundamentals. 2 Hours.**

Semester course; 2 lecture hours. 2 credits. Enrollment is restricted to students with graduate standing. The goal of this course is to provide training in science communication to diverse audiences from scientific and nonscientific backgrounds and across diverse career paths. The course covers fundamental rules of writing, the writing process, technical writing, visual presentation, oral presentation, engaging audiences and communication with the public. Students will attain science communication skills through writing exercises, videotaped oral exercises and peer review to prepare them for graduate school and beyond.

**BIOL 608. Science Communication: Research Proposals. 2 Hours.**

Semester course; 2 lecture hours. 2 credits. Enrollment is restricted to students with graduate standing. The goal of this course is to provide training in writing competitive research proposals. Students will learn the necessary skills for the proposal-writing stage of scientific research preparatory stage, including reference managers, annotated bibliographies, selling the idea, mock review panels, short-form proposals, long-form proposals and thesis/dissertation proposals. Students will learn proposal-writing skills that will provide an edge in applications for a diversity of funding sources.

**BIOL 609. Scientific Communication: Public Discourse. 1 Hour.**

Semester course; 1 lecture hour. 1 credit. Prerequisite: BIOL 607. Enrollment is restricted to students with graduate standing. The mission of this course is to train students nearing completion of a thesis/dissertation to apply skills they learned in the prerequisite course to effectively communicate their own thesis/dissertation research, and its relevance to global issues in biology, to nonscientific audiences. Students successfully completing this course will be able to effectively communicate the science and relevance of their own research in verbal and written formats with non-scientists in the lay public, government and nongovernment institutions and the media. Graded as satisfactory/unsatisfactory.



**BIOL 610. Conservation Applications. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Covers the implementation of conservation techniques including monitoring, planning, education, habitat management and combining conservation with human development strategies. Focuses on how to make conservation work where biodiversity and human livelihoods must be reconciled. Students will utilize a number of computer programs to analyze and interpret management strategies.

**BIOL 618. Ecosystems Ecology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: BIOL 317 or equivalent or permission by instructor. Introduction to the structure and functioning of aquatic and terrestrial ecosystems. The course complements other offerings in the graduate program by considering ecological processes at higher orders of organization and in the context of abiotic factors. Students will gain discipline-specific knowledge through lectures and readings while building quantitative and critical thinking.

**BIOL 620. Biogeochemistry. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Enrollment restricted to graduate students. This course will examine the biogeochemical cycles of carbon, nitrogen, phosphorus, sulfur and iron on Earth from both a historical perspective and in the context of global environmental change, considering the cycles individually while also acknowledging that there are significant interactions between these cycles. Examples of biogeochemical processes will be drawn from multiple ecosystems, ranging from terrestrial soils to the deep ocean.

**BIOL 626. Physiological Ecology. 4 Hours.**

Semester course; 4 lecture hours. 4 credits. Prerequisite: BIOL 317 or equivalent. This course examines the physiological adjustments and adaptations made by organisms in response to their environment.

**BIOL 630. Patterns of Mammalian Reproduction. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. A comprehensive ecological and evolutionary study of specializations and adaptive radiation in mammalian reproductive anatomy, the reproductive cycle, seasonality of reproduction and factors affecting litter size and developmental state of neonates. Human reproductive biology is included when pertinent.

**BIOL 640. Evolution and Molecular Markers. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Methodologies and applications of molecular biology as they pertain to the study of evolution, with a focus on systematics, speciation and biogeography. The course provides proficiency in the understanding, interpretation and choice of appropriate molecular markers for evolutionary research, with particular attention to current methods and recent literature. Designed to benefit students of both natural history (ecologists, systematics, evolutionary biologists) and molecular biology.

**BIOL 650. Conservation Genetics. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Covers the application of molecular genetics to biodiversity conservation. Essential topics include molecular measures of genetic diversity, estimating loss of genetic diversity in small populations, detecting inbreeding, resolution of taxonomic uncertainties, genetic management of T&E species, captive breeding and reintroduction. Students will utilize a number of computer programs to analyze and interpret molecular genetic data.

**BIOL 654. Environmental Remote Sensing. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: ENVS 602, or permission of the instructor. This course provides a basic and applied understanding on the use of digital remote sensor data to detect, identify and characterize earth resources. Students are required to demonstrate an understanding of the spectral attributes of soils, vegetation and water resources through various labs involving both image- and non-image-based optical spectral data. Crosslisted as: ENVS 654/URSP 654.

**BIOL 660. Developmental Biology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: biochemistry or cell biology or their equivalent. Molecular and cellular principles of developmental biology in model systems, including flies, worms, fish and mammals. Understanding of morphogen gradients, transcription, cell movements and signaling in development. Advanced methods are taught enabling students to interpret and present findings from the primary literature.

**BIOL 676. Plant and Animal Cell Biology. 3 Hours.**

Semester course; 3 lecture hours. 3 credits. Prerequisite: biochemistry or cell biology or permission of instructor. Molecular and cellular principles of cell behavior and function in plant and animal cells. Topics include intracellular transport, cell cycle control, signaling and cell motility. Advanced methods are taught enabling students to interpret and present findings from the primary literature in this field.

**BIOL 690. Biology Seminar. 1 Hour.**

Semester course; 1 credit. May be repeated for credit. Presentations by faculty and visiting lecturers, and discussions of research and developments in biology and related fields. Graded as S/U/F.

**BIOL 691. Special Topics in Biology. 1-4 Hours.**

Semester course; variable hours. 1-4 credits. An advanced study of a selected topic in biology. See the Schedule of Classes for specific topics to be offered each semester and prerequisites. If several topics are offered, students may elect to take more than one.

**BIOL 692. Independent Study. 1-4 Hours.**

Semester course; hours to be arranged. Credits to be arranged. Determination of the amount of credit and permission of instructor, adviser and department chair must be obtained prior to registration for this course. A course designed to provide an opportunity for independent research in any area of biology outside the graduate student thesis area.

**BIOL 693. Current Topics in Biology. 1 Hour.**

Semester course; 1 lecture hour. 1 credit. May be repeated for credit. Designed to develop skills in preparing and delivering oral presentations in conjunction with an in-depth study of a current topic in biology. Students present talks and lead discussions on the selected topic.

**BIOL 698. Thesis. 1-16 Hours.**

Semester course; hours to be arranged. Credits to be arranged. Independent research by students in areas of systematics, environmental, developmental, behavioral, cellular and molecular biology, and comparative physiology.