

# DEPARTMENT OF BIOLOGY

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biology.vcu.edu (<http://biology.vcu.edu/>)

The Department of Biology offers programs leading to baccalaureate, master's and doctoral degrees; the doctoral degree is offered through the Ph.D. in Integrative Life Sciences program. Students may specialize within many areas, such as molecular and cellular biology, genetics, aquatic and terrestrial ecology, systematics, physiology, neurobiology, and developmental biology. Students also may develop an interdisciplinary focus to their degree program, for example within areas such as bioinformatics, cancer biology, forensic science and environmental science.

In addition to the courses offered by the Department of Biology, graduate students may enroll in graduate courses offered through VCU Life Sciences and these departments in the VCU School of Medicine: Anatomy and Neurobiology, Biochemistry and Molecular Biology, Biostatistics, Human and Molecular Genetics, Microbiology and Immunology, Pathology, Pharmacology and Toxicology, and Physiology and Biophysics. Visit the Department of Biology's website (<http://biology.vcu.edu/>) for additional information.

- Biology, Master of Science (M.S.) (<http://bulletin.vcu.edu/graduate/college-humanities-sciences/biology/biology-ms/>)

### 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.