
Biology

Robert I. Bertin, Ph.D., *Professor*

George R. Hoffmann, Ph.D., *Distinguished Professor of Science*

Kenneth N. Prestwich, Ph.D., *Professor and Chair*

Robert M. Bellin, Ph.D., *Associate Professor*

Leon Claessens, Ph. D., *Associate Professor*

Karen A. Ober, Ph.D., *Associate Professor*

Ann M. Sheehy, Ph.D., *Associate Professor*

William V. Sobczak, Ph.D., *Associate Professor*

Madeline Vargas, Ph.D., *Associate Professor*

Sara G. Mitchell, Ph.D., *Assistant Professor*

Michelle A. Mondoux, Ph.D., *Assistant Professor*

Sarah Webster, Ph.D., *Assistant Professor*

Brian Moskalik, Ph.D., *Andrew W. Mellon Postdoctoral Teaching Fellow*

Julie A. Roden, Ph.D., *Visiting Assistant Professor*

Jodi M. Rymer, Ph.D., *Visiting Assistant Professor*

Kelly Wolfe-Bellin, Ph.D., *Visiting Assistant Professor*

James M. Doyle, M.A., *Senior Laboratory Supervisor*

Catherine M. Dumas, M.S., *Laboratory Supervisor*

Peter J. Lemay, M.S., *Laboratory Supervisor*

The biology curriculum is designed to acquaint students with the broad scope of the biological sciences at several levels of functional organization. Its courses include molecular, cellular, organismal, ecological, and evolutionary aspects of biology. Departmental course offerings prepare biology majors for advanced study in graduate or professional schools and for other professional opportunities. The Department believes that an informed understanding of biological principles is an important aspect of a liberal arts education, and it therefore offers diverse courses that introduce non-majors to basic biological concepts and explore the implications of modern biology for various social and ethical issues. Our curriculum also offers courses in geology to inform majors and non-majors about the history of the Earth, geologic materials, and the physical processes operating within the Earth and on its surface.

Biology majors are required to take at least eight biology courses, six with laboratory. Required courses include Biology 131 and 132 (Introduction to Biology with laboratory) and either Biology 261 (Genetics with laboratory) or Biology 262 (Genetic Analysis, without laboratory). A student must earn a grade of C or better in Biology 131 and 132 to continue in the major. They must also complete Chemistry 181, 221, 222, 231 (all with laboratory); Mathematics 131, 132, or the equivalent (Mathematics 133, 134; Mathematics 136; or appropriate Advanced Placement); and Physics 111 and 112 (both with laboratory) or the equivalent (Physics 115 and 116, which include laboratories). Students may substitute Biology 150 (Introduction to Geology with laboratory) for either Physics 112 (or 116) or Chemistry 222, if these courses are not otherwise required for their academic program and the switch is approved by the Chair. Biology students normally complete the chemistry sequence before beginning their third year.

Since study beyond the undergraduate level is typically specialized, the Department encourages a balanced approach to the discipline by requiring its majors to include among their upper-division biology courses one course from each of the following broadly defined areas: (1) molecular and cellular biology, (2) organismal biology, and (3) ecological and evolutionary biology. Of the minimum total of eight biology courses, at least six must be taken at Holy Cross. Other courses, up to a maximum of 14, may be taken at Holy Cross or, with the Chair's permission, in other programs, such as Study Abroad, Study Away, the Worcester Consortium or summer school.

In addition to formal courses, the Department offers qualified students an opportunity to conduct research (Biology 401) in association with faculty members in their research laboratories. Opportunities also exist for students to pursue individual interests in faculty-directed readings courses based on

biological literature (Biology 405). Students conducting research for a thesis in the College Honors Program must elect Biology 407, 408.

Biochemistry Concentration

The Departments of Biology and Chemistry jointly offer a concentration that focuses on the study of the chemistry underlying biological structure and function. Concentrators must be enrolled as either biology or chemistry majors. Participants take Biology 131 (or 120), 301, and 302 with laboratories; Chemistry 181, 221, 222, 231, and 336 (or equivalent); and one additional biology course with an associated biochemistry-oriented laboratory, in addition to the usual courses required of their major. Concentrators must also complete a two-semester thesis project in their fourth year involving research on some aspect of biochemistry. Admission to the concentration is competitive and occurs in the second semester of the second year. Interested students should contact the Concentration Coordinator or the Chair of either department.

Biological Psychology Concentration

The Departments of Biology and Psychology jointly offer a concentration that concerns the study of neuroscience and behavior. The concentration requires an understanding of various scientific fields including core areas of biology, psychology, chemistry, physics, mathematics, and computer science. Concentrators major in either biology or psychology, and have the opportunity to take courses designated as belonging in the concentration from either department. For Biology majors, additional requirements include Psychology 100 (Introduction to Psychology) and at least one of the four additional concentration courses from the Psychology Department. Students are exposed to original research throughout the concentration in a weekly seminar and by conducting two semesters of thesis research in their fourth year. Admission to the concentration is competitive and is limited to eight students per class year. Interested students should consult with the Concentration Coordinator or the Chair of the Biology or Psychology Department prior to registering for second-year courses.

Advanced Placement Credit: Students with AP credit in Biology do not receive credit toward the minimum number of course required by the major or advanced standing in the Biology curriculum.

Courses

Biology 114 — Biological Principles

Fall, spring

These courses introduce non-science majors to principles and modes of inquiry underlying the study of living things. Each course examines a subset of subject matter, which may range from biological molecules and cells to the structure and function of organisms to interactions of organisms with their environments. All courses in this series share the common goal of providing a rigorous introduction both to the methods of scientific inquiry and to the content of the discipline. Recently taught subjects include evolution, microbiology, cancer, environmental biology, the molecular biology of the HIV pandemic, toxicants and radiation, biology of the brain, biology of aging, human anatomy and physiology, and conservation biology. One unit.

Biology 120 — General Biology 1

Fall

Fundamental principles of biology studied at the molecular and cellular levels of organization. Intended for third and fourth-year premedical students majoring in subjects other than biology. Includes laboratory. Prerequisite or Corequisite: Chemistry 221. One and one-quarter units.

Biology 121 — General Biology 2

Spring

A continuation of Biology 120. A study of levels of biological organization from tissues to populations and the diversity of life. Includes laboratory. Prerequisite: Biology 120. One and one-quarter units.

Biology 131 — Introduction to Biology 1

Fall

Selected topics emphasizing biological organization at the cellular and molecular levels. Designed for biology majors, this course is prerequisite for upper-division courses in the Department. Includes laboratory. One and one-quarter units.

Biology 132 — Introduction to Biology 2*Spring*

A study of the structure, function, diversity, and evolution of plants, fungi and invertebrates. Includes laboratory. Open to biology majors and prospective biology majors. One and one-quarter units.

Biology 140 — Environmental Geology*Alternate years, fall*

An introduction to the relationship between humans and the materials and processes of the Earth. This course focuses on three general topics: geological hazards, climate change, and natural resources. Students may not take both Biology 140 and Biology 150 (Introduction to Geology). One unit.

Biology 150 — Introduction to Geology*Fall*

The physical processes operating on the earth and the history of the earth. Topics include the formation and physical properties of rocks and minerals, plate tectonics, geologic time, geologic hazards, weathering and erosion, global climate change, and the geology of mineral and energy resources. Field trips to local geologic sites provide hands-on experience using classic and modern approaches to investigating the earth and its history. Open to all students. Particularly suitable for Biology majors interested in paleontology, ecology, or evolution and for Environmental Studies majors, or concentrators. Includes laboratory. One and one-quarter units.

Biology 199 — Introductory Problems in Biology*Annually*

A first-time course offering in various sub-disciplinary topics of biology.

Biology 210 — Geomorphology*Spring*

This course is an introduction to landforms and the geologic processes that modify Earth's surface. Topics include tectonic, hillslope, glacial, and river processes; modern quantitative methods of investigating landscapes; and the influences of humans, climate, and biologic activity on surficial processes and the physical environment. Includes computer and field work in the weekly laboratory. One and one-quarter units.

Biology 213 — Comparative Vertebrate Morphology*Fall*

The structure, function, development and evolution of the skeletal, muscular, nervous, respiratory, circulatory, digestive and urogenital systems of the chordates, with special emphasis on vertebrates. Includes laboratory. Organismal biology. Prerequisite: Biology 131. One and one-quarter units.

Biology 220 — Entomology*Fall*

An introduction to insects covering diversity, morphology, physiology, ecology and behavior, as well as considerations of the economic and medical importance of insects. Includes laboratory. Organismal biology. Prerequisite: Biology 131 and 132. One and one-quarter units.

Biology 223 — Microbiology*Fall*

A comprehensive introduction to microbiology. This course provides an overview of microorganisms, including their structure and function, growth, ecology, genetics, taxonomy, and evolution. Emphasis is placed on prokaryotes and viruses. The laboratory emphasizes enrichment and pure culture methods, diagnostic microbiology, and physiology. Includes laboratory. Molecular and cellular biology. Prerequisites: Biology 120 or 131; Prerequisite or Corequisite: Chemistry 222. One and one-quarter units.

Biology 233 — Freshwater Ecology*Fall*

A comprehensive introduction to the hydrology, chemistry, and ecology of freshwater ecosystems. The laboratory component includes field work in several ecosystems (lake, stream, reservoir, river and wetland) and laboratory work characterizing the chemistry and biology of these diverse ecosystems. Includes laboratory and field work. Ecological and evolutionary biology. Prerequisite: Biology 132. One and one-quarter units.

Biology 250 — Field Botany*Alternate years, fall*

An introduction to the local vascular flora, emphasizing identification of ferns, woody plants and plants flowering in the fall. The course will include training in use of field guides and technical keys and preparation of herbarium specimens. Includes field and laboratory work. Organismal biology. Prerequisite: Biology 132 or permission. One unit.

Biology 255 — Vertebrate History*Spring*

A survey of vertebrate history, with emphasis on the anatomical and physiological transformations that occurred at the evolutionary originations of the major vertebrate groups. Structure and function of both extant and extinct taxa are explored, as documented by modern fauna and the fossil record. Includes laboratory. Organismal biology. Prerequisites: Biology 131 and 132. One and one-quarter units.

Biology 261 — Genetics*Fall*

The mechanisms of heredity and genetic analysis. Topics include Mendelian inheritance, chromosome structure and function, genetic mapping, molecular genetics, mutation, genetic regulation, and population genetics. The laboratory emphasizes genetic principles through experimental work with bacteria, fungi, vascular plants, and fruit flies, and interpretive studies in human genetics. Includes laboratory. Prerequisites: Chemistry 221 and Biology 131 and 132. One and one-quarter units.

Biology 262 — Genetic Analysis*Every third year, spring*

The mechanisms of heredity and genetic analysis. Topics include Mendelian inheritance, chromosome structure and function, genetic mapping, molecular genetics, mutation, genetic regulation, and population genetics. This course is a nonlaboratory equivalent of Biology 261. Prerequisites: Chemistry 221 and Biology 131 and 132. One unit.

Biology 266 — Cell Biology*Spring*

The structure and function of cells of higher organisms, both animal and plant, are considered along with aspects of metabolism and enzyme action. Special topics such as growth regulation or function of the immune system may be discussed according to student interest. The critical evaluation of experimental evidence is emphasized. Includes laboratory. Molecular and cellular biology. Prerequisites: Biology 131 or 120; Biology 261 or 262, and Chemistry 221 is recommended. One and one-quarter units.

Biology 267 — Neurobiology*Spring*

A study of the nervous system at multiple levels, from molecular to the systems level. Major topics cover the range of these levels and include: structure of the nervous system and neurons, generation of electric signals, synapses, structure and function of sensory and motor circuits, and a discussion of higher order processing. Includes laboratory. Molecular and cellular biology. Prerequisites: Biology 120 or 131. One and one-quarter units.

Biology 275 — Biological Statistics*Spring*

An introduction to the handling, analysis, and interpretation of biological data. Topics include descriptive statistics, probability distributions, goodness of fit tests, hypothesis testing, analysis of variance, regression, and correlation. Prerequisites: Biology 120 or 131 or permission. One unit.

Biology 280 — General Ecology*Fall*

A broad introduction to the study of relationships between organisms and their environments, with coverage of individual organisms, populations, communities and ecosystems, as well as natural history of New England. Includes laboratory and field work. Ecological and evolutionary biology. Prerequisite: Biology 131 and 132. One and one-quarter units.

Biology 283 — Evolution*Annually*

An inquiry-based approach to the study of evolution and Darwin's theory of natural selection. Most attention will be devoted to empirical work that addresses conceptual issues in evolutionary biology, including natural selection, speciation, coevolution, sexual selection, molecular evolution, analysis of adaptation, evolutionary biogeography, and micro- versus macroevolution. Ecological and evolutionary biology. Prerequisites: Biology 131 and 132. One unit.

Biology 287 — Ethology and Behavioral Ecology*Alternate years*

A comparative look at animal behavior and the evolutionary forces that shape it. Topics include physiological mechanisms of behavior, behavioral genetics and heritability, communication, foraging, competition and cooperation, mating and parenting systems, and social behavior. The importance of good experimental design and the proper role of modeling in behavioral studies are emphasized. Field projects are included. Ecological and evolutionary biology. Prerequisite Biology 131 and 132 or permission. One unit.

Biology 299 — Intermediate Problems in Biology*Annually*

A first-time course offering in various sub-disciplinary topics of biology.

Biology 301 — Biochemistry 1*Fall*

A detailed study of the chemistry of biological molecules. Topics include the structural chemistry of the major classes of biological compounds, enzyme catalysis, bioenergetics, metabolic regulation, glycolysis, gluconeogenesis, beta-oxidation of fatty acids, tricarboxylic acid cycle, electron transport chain and oxidative phosphorylation. Molecular and cellular biology. Equivalent to Chemistry 301. Prerequisites: Chemistry 222. One unit.

Biology 302 — Biochemistry 2*Spring*

A continuation of Biology 301. Topics include the chemistry, enzymology and regulation of lipid, protein and carbohydrate metabolism, photosynthesis, DNA replication, transcription, and translation. Molecular and cellular biology. Prerequisite: Biology 301 or Chemistry 301. One unit.

Biology 303 — Biochemistry 1 Laboratory*Fall*

This laboratory accompanies Biology 301 and introduces students to experimental methods used for the purification and characterization of biological molecules through a multi-week, full-semester procedure. While conducting the steps of this overall procedure, students gain experience with a wide range of biochemistry lab techniques including column chromatography, gel electrophoresis, Western blotting, and enzyme activity assays. This laboratory is taken as a fifth course; while figured into the GPA, it does not count as one of the 32 courses required for graduation. Prerequisite or corequisite: Biology 301. One-half unit.

Biology 304 — Biochemistry 2 Laboratory*Spring*

This laboratory accompanies Biology 302 and introduces students to the principles and methods of molecular biology as they relate to the modern practice of laboratory biochemistry. Through a multi-week, full-semester procedure, students are exposed to a wide-range of techniques including genomic DNA isolation, PCR, plasmid DNA construction, sequence analysis and recombinant protein expression. This laboratory is taken as a fifth course; while figured into the GPA, it does not count as one of the 32 courses required for graduation. Prerequisite or corequisite: Biology 302. One-half unit.

Biology 331 — Ecosystem Ecology*Spring*

The course covers the history of ecosystem ecology, biogeochemical cycles and budgets, ecosystem energetics and trophic structure, and the response of ecosystems to disturbance and human-accelerated environmental change. The latter part of the course emphasizes discussion of recent primary literature that contributes to the conceptual framework underlying the management and conservation of diverse ecosystems. Ecological and evolutionary biology. Prerequisites: Biology 131 and 132. One unit.

Biology 341 — Virology*Fall*

This course is a general introduction to virology. It covers virus classification and structure, how viruses enter cells and replicative effects of viruses on host cells, interactions with the host immune system and viral disease. Molecular and Cellular. Prerequisites: Biology 261 or 262 or 266. One unit.

Biology 361 — Toxicology*Annually*

The study of adverse effects of chemicals on biological systems. Topics include measurements of toxicity; dose-response relationships; the absorption, distribution, metabolism and excretion of toxicants; targets of toxicity; genetic toxicology; carcinogenesis; developmental toxicity; environmental toxicology; and regulatory toxicology. Organismal biology. Prerequisites: Chemistry 222 and Biology 120, 261, or 262. One unit.

Biology 381 — Conservation Biology*Alternate years, spring*

A study of the effects of human activity on biological diversity at the population and system levels. Topics include the underlying philosophical approaches to conservation, techniques for measuring biological diversity, for assessing and predicting changes, the principles of management and restoration and the use of mathematical models in management. Classes will be a mix of lecture on general principles plus student-led discussion of case studies and of the recent conservation literature. Ecological and evolutionary biology. Prerequisite: Biology 261 or 262 or 233 or 280 or 331. One unit.

Biology 390 — Animal Physiology*Annually*

A comparative approach to the functioning of cells, organs, and organisms. Major themes are homeostasis, control mechanisms, and adaptation to the environment. Topics include: excitable and contractile cell physiology, energy metabolism and temperature regulation, respiration and circulation, digestion, water balance, and coordination and control of these systems by neuroendocrine mechanisms. Includes laboratory. Organismal biology. Prerequisites: Chemistry 231 and Biology 120 or 131. Prerequisite or Corequisite: Physics 111 or 115. One and one-quarter units.

Biology 392 — Molecular Immunology*Alternate years*

The course examines the components of the immune system. It covers the genetics, structure and function of antibodies, immune receptors and messengers, tolerance, hypersensitivity, autoimmunity and immunodeficiency. Includes laboratory. Molecular and cellular biology. Prerequisites: Biology 261, 262 or 266. One and one-quarter units.

Biology 399 — Advanced Problems in Biology

Annually

A first-time course offering in various sub-disciplinary topics of biology.

Biology 401 — Undergraduate Research

Annually

Individual experimental investigation and associated study of the scientific literature under the direct supervision of a member of the faculty. The number of positions is limited; students contemplating research should make inquiries early in the year preceding the term in which research is to be initiated. Prerequisite: permission of instructor. One semester may be counted toward the biology major; additional semesters may be taken for college credit. One and one-quarter units.

Biology 405 — Directed Reading

Annually

An in-depth literature study of a topic of interest to the student under the tutorial supervision of a member of the faculty. Prerequisite: permission of instructor. One unit.

Biology 407, 408 — Honors Research

Annually

Individual experimental investigation and associated study of the scientific literature under the direct supervision of a faculty member. Students contemplating research should make inquiries early in the year preceding the term in which research is to be initiated. One semester may be counted towards the biology major; additional semesters may be taken for college credit. Open only to students in the College Honors Program. One and one-quarter units each semester.