

# Biology

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The biology program lays a foundation for graduate study in biology, and for training in the professions and technologies based upon the biological sciences. The faculty believes that students should be broadly trained; should be knowledgeable in an area of specialization; should understand the process by which scientists ask and pursue the answers to questions; and should be acquainted with ethical principles and issues as they relate to the field of biology.

Both the B.A. and B.S. degrees are awarded in Biology. B.S. students must complete 36 credits in biology while B.A. students must complete 33 credits. Freshmen students begin with General Biology (BL 150-153) where cellular, organismal and population biology are introduced. Subsequently, they elect one of the three areas for concentration. During the sophomore, junior and senior years, they complete Cell Biology, one advanced course with lab in each of the three areas, and an additional advanced course with lab in their chosen concentration. Additionally, during the last semester of the junior year and through the senior year, students plan and complete a senior research project under the supervision of an individual faculty member. Finally, students also must complete one year of General Chemistry, one year of Organic Chemistry, and one year of Physics. B.S. students must complete one year of Calculus while one semester of Calculus is required of students electing the B.A. degree. It is strongly recommended that B.A. students complete a second semester of Calculus, and that all students complete one semester of Statistics before their senior year. General Biology is a prerequisite for all advanced courses. With the exception of General Biology, only courses above BL 200 may be applied toward the total biology credits required.

In individual circumstances and with permission of the chairperson, a course may be substituted for one of the required courses listed under the cellular, organismal, and population concentrations. Variations can and do occur depending on the goals or problems encountered. Students should work closely with their advisors.

Students are cautioned to give careful and serious consideration to the selection of courses because requirements and recommended courses may differ among professional and graduate schools.

Finally, since questions of an ethical and moral nature often arise in biology and related fields, students are encouraged to include a course on these issues in their curriculum.

## Teacher Preparation

Additional Science Course Requirements for Certification in Biology (7-12):

In addition to a major in biology, the certification candidate must satisfy the following special requirements:

PH 106	Physical Geology	3
PH 107	Physical Geology Laboratory	1

See Education Department guidelines to plan core classes and other courses required for certification.

## Requirements for a Bachelor of Arts Degree in Biology

(See Core Curriculum requirements.)

### Major Requirements (61 credits):

BL 150, 152	General Biology I and II	6
BL 151, 153	General Biology Laboratory I and II	2
BL 208	Cell Biology	3

BL 209	Cell Biology Laboratory	1
BL 301	Junior Research Seminar	2
BL 302	Research Project	2
BL 303	Research Thesis	1
CH 101, 102	General Chemistry I and II	6
CH 103,104	General Chemistry Laboratory I and II	2
CH 221, 222	Organic Chemistry I and II	6
CH 223, 224	Organic Chemistry Laboratory I and II	2
PH 111, 112	General Physics I and II	6
PH 113,114	General Physics Laboratory I and II	2
MA 109	Calculus I	4

Fulfill the requirements for one area of concentration:

### Cell and Molecular Biology Concentration:

BL 214	Molecular Genetics	3
BL 215	Molecular Genetics Laboratory	1
and		
BL 212	Microbiology	3
BL 213	Microbiology Laboratory	1
or		
BL 216	Biotechnology	3
BL 217	Biotechnology Laboratory	1
One course with laboratory from each of the organismal and population biology areas.		8

### Organismal Biology Concentration:

BL 220	Comparative Vertebrate Anatomy	3
BL 221	Comparative Vertebrate Anatomy Laboratory	1
or		
BL 222	Developmental Biology	3
BL 223	Developmental Biology Laboratory	1
and		
BL 224	Mammalian Physiology	3
BL 225	Mammalian Physiology Laboratory	1
One course with laboratory from each of the cellular and population areas.		8

### Population Biology Concentration:

BL 232	Ecology	3
BL 233	Ecology Laboratory	1
or		
BL 236	Biology of Environmental Disturbances	3
BL 237	Biology of Environmental Disturbances Laboratory	1
and		
BL 234	Evolution and Systematics	3
BL 235	Evolution and Systematics Laboratory	1
One course with laboratory from each of the cellular and organismal areas.		8

### Strongly Recommended:

PY 203	Statistics	3
and		
RS 282	Christian Bioethics	3
or		
PL 218	Bioethics	3

## Requirements for a Bachelor of Science Degree in Biology

(See Core Curriculum requirements.)

### Major Requirements (68 credits):

BL 150, 152	General Biology I and II	6
BL 151,153	General Biology Laboratory I and II	2
BL 208	Cell Biology	3
BL 209	Cell Biology Laboratory	1
BL 301	Junior Research Seminar	2
BL 302	Research Project	2
BL 303	Research Thesis	1
CH 101, 102	General Chemistry I and II	6
CH 103, 104	General Chemistry Laboratory I and II	2
CH 221, 222	Organic Chemistry I and II	6
CH 223, 224	Organic Chemistry Laboratory I and II	2
PH 111, 112	General Physics I and II	6
PH 113, 114	General Physics Laboratory I and II	2
MA 109, 110	Calculus I and II	8
Elective Course in Biology		3

Fulfill the requirements for one area of concentration:

**Cell and Molecular Biology Concentration:**

BL 214	Molecular Genetics	3
BL 215	Molecular Genetics Laboratory	1
and		
BL 212	Microbiology	3
BL 213	Microbiology Laboratory	1
or		
BL 216	Biotechnology	3
BL 217	Biotechnology Laboratory	1

One course with laboratory from each of the organismal and population biology areas. 8

**Organismal Biology Concentration:**

BL 220	Comparative Vertebrate Anatomy	3
BL 221	Comparative Vertebrate Anatomy Laboratory	1
or		
BL 222	Developmental Biology	3
BL 223	Developmental Biology Laboratory	1
and		
BL 224	Mammalian Physiology	3
BL 225	Mammalian Physiology Laboratory	1

One course with laboratory from each of the cellular and population areas. 8

**Population Biology Concentration:**

BL 232	Ecology	3
BL 233	Ecology Laboratory	1
or		
BL 236	Biology of Environmental Disturbances	3
BL 237	Biology of Environmental Disturbances Laboratory	1
and		
BL 234	Evolution and Systematics	3
BL 235	Evolution and Systematics Laboratory	1

One course with laboratory from each of the cellular and organismal areas. 8

**Strongly Recommended:**

PY 203	Statistics	3
and		
RS 282	Christian Bioethics	3
or		
PL 218	Bioethics	3

**Requirements for Minor in Biology (26 credits)**

All students must complete the following courses:		
BL 150, 152	General Biology I and II	6
BL 151, 153	General Biology Laboratory I and II	2
CH 101, 102	General Chemistry I and II	6
CH 103, 104	General Chemistry Laboratory I and II	2

Additionally, students must complete 10 credits from the courses listed below. Two lecture-laboratory course combinations, each combination from a different area of concentration, must be included. Students may complete the remaining credits in any concentration.

**Cell and Molecular Biology Concentration:**

BL 208	Cell Biology	3
BL 209	Cell Laboratory	1
BL 212	Microbiology	3
BL 213	Microbiology Laboratory	1
BL 214	Molecular Genetics	3
BL 215	Molecular Genetics Laboratory	1
BL 216	Biotechnology	3
BL 217	Biotechnology Laboratory	1
BL 242	Histology	2
BL 243	Histology Laboratory	1
BL 248	Environmental Microbiology	3
BL 249	Environmental Microbiology Laboratory	1
BL 250	Medical Microbiology	3
BL 251	Medical Microbiology Lab	1
CH 252	Nucleic Acids and Membranes	3
CH 254	Nucleic Acids and Membranes Laboratory	1

**Organismal Biology Concentration:**

BL 220	Comparative Vertebrate Anatomy	3
BL 221	Comparative Vertebrate Anatomy Laboratory	1
BL 222	Developmental Biology	3
BL 223	Developmental Biology Laboratory	1
BL 224	Mammalian Physiology	3
BL 225	Mammalian Physiology Laboratory	1

**Population Biology Concentration:**

BL 232	Ecology	3
BL 233	Ecology Laboratory	1
BL 234	Evolution and Systematics	3
BL 235	Evolution and Systematics Laboratory	1
BL 236	Biology of Environmental Disturbances	3
BL 237	Biology of Environmental Disturbances Laboratory	1

**Typical Freshman Year Schedule**

First Semester (14-15 credits):		
BL 150	General Biology I	3
BL 151	General Biology Laboratory	1
CH 101	General Chemistry I	3
CH 103	General Chemistry Laboratory	1
EL 102	Language and Rhetoric	3
or		
RS 119	Exploring Religious Meaning	
	Core course (History, Social Science, etc.)	3-4
	or Calculus	

All students will take one three (3) credit course designated as a Freshman Seminar which will satisfy a Core Curriculum requirement.

**Second Semester (17-18 credits):**

BL 152	General Biology II	3
BL 153	General Biology Laboratory II	1
CH 102	General Chemistry II	3
CH 104	General Chemistry II Laboratory	1
EL 102	Language and Rhetoric	3
or		
RS 119	Exploring Religious Meaning	
	Core courses (History, Social Science, etc.)	
	or Calculus	6-7

**Course Descriptions**

Note: BL 150-153 are prerequisites for all courses above the 100 level.

**BL 100 Introduction to Biology**

This course provides insight into the organization of living systems at the molecular, cellular, organismal and populational levels. Emphasized are the structural and functional characteristics common to most organisms, organismal diversity, biological evolution, and interactions between organisms and their environment. The laboratory is designed to introduce the process of science and the characteristics of scientific knowledge. Students learn to formulate questions and hypotheses, design simple experiments, interpret results, draw conclusions and present their work in scientific formats. For non-science majors. Tier 1 course, no prerequisite. Four credits.

**BL 102 Exercise and Sport Physiology**

An introduction to the short- and long-term responses of the human body to physical activity, with emphasis on neuromuscular physiology, fuel metabolism and cardiorespiratory function. The influence of diet, training and ergogenic aids on athletic performance and their biological bases will be discussed. Physical inactivity as a risk factor for disease will be addressed. The laboratory component is designed to reinforce concepts presented in lecture. For non-science majors. Tier 2 course, any Tier 1 course serves as a prerequisite. Four credits.

**BL 104 Field Biology**

This combined lecture/laboratory course is designed to introduce

non-science students to the study of living organisms through direct observations in streams, pastures, lakes and forests. We will follow examples of ancient and modern field biologists as we develop background knowledge and skills in natural history, field collection methods and modern analysis of field data. Be prepared to work outside during each class, wearing old shoes, hip boots, or a life vest. For non-science majors. Tier 1 course, no prerequisite. Four credits.

### **BL 112 Understanding Biotechnology**

This integrated lecture-laboratory course is focused on the ways in which our understanding of biological systems is applied for practical purposes. The lecture portion addresses the basic biology and theory behind topics such as genetic engineering of microbes, plants, and animals for agricultural, industrial, and medical purposes; cloning of genes, plants and animals; as well as, DNA analysis in forensic science and medicine. Special consideration is given to the ethical issues raised by the application of these technologies. The laboratory component is designed to reinforce the scientific method while providing hands-on experience with DNA technologies and forensics analyses. For non-science majors. Tier 1 course, no prerequisite. Four credits.

### **BL 114 Human Biology and Laboratory**

A study of the structure, function and development of the human body. The laboratory consists of microscopic studies, gross dissections and demonstrations. For non-science majors. Tier 2 course, any Tier 1 course serves as a prerequisite. Four credits.

### **BL 116 Bacteria, Friends or Foes?**

This course will include discussions, lectures, and laboratories to study the tiny creatures that surround us known as microorganisms, particularly bacteria and viruses. The course will study the two-sided relationship between microorganisms and man. Most people think of bacteria and viruses as harmful because they cause disease. On the other hand, these tiny entities have many positive roles in our society including advancing biotechnology, food and beverage production, and roles in the environment including degrading of materials and cycling of nutrients. These and other topics will be discussed. For non-science majors. Tier I course, no prerequisite. Four credits.

### **BL 150, 152 General Biology I and II**

This year-long course is intended for science majors. The first semester addresses the biology of cells, and animal physiology, development, and taxonomy. The second semester continues with plant biology, classical and molecular genetics, and ecology and evolution. At the conclusion of the course, Biology majors select cell and molecular biology, organismal biology or population biology as an area of concentration for subsequent work. A passing grade in BL 150 is required for BL 152. Three credits each semester.

### **BL 151, 153 General Biology I and II Laboratory**

This course introduces scientific method, statistics, laboratory techniques, and the use of instruments as students perform experiments that reinforce and expand upon ideas presented in BL 150 and 152. One credit each semester.

### **BL 208 Cell Biology**

This course is an intensive examination of cell ultrastructure and function. Emphasis is placed on the role of specific organelles in cellular processes such as membrane structure, function, biogenesis and recycling; protein structure, assembly, modification and trafficking; energy transduction; intracellular transport; cell cycle control; and cell to cell communication. Reference is made to the ways in which cells are studied and a section on microscopy is included. Where relevant, the relationship of individual cells within the environ-

ment of an integrated multicellular organism is addressed. Three credits.

### **BL 209 Cell Biology Laboratory**

The laboratory is designed to familiarize the student with the general methods used to study the physical nature of cells and their inherent biochemical processes. Experimental techniques performed range from the measurement of cell growth rates to the differential purification and biochemical analysis of subcellular components. One credit.

### **BL 260 Biostatistics**

This course deals centrally with quantitative and statistical methodology in the biological sciences. It includes experimental design and the conventions of generating, analyzing, interpreting and presenting biological data. Three credits.

## **Cell and Molecular Biology**

A study of complex cellular processes and interactions through characterization of the structure and function of their molecular components.

### **BL 212 Microbiology**

This course will introduce students to Microbiology, the study of microorganisms with a focus on bacteria and viruses. The course will include discussions and lectures on the history of Microbiology, microbial growth and metabolism, and microbial genetics. The impact of microorganisms in the environment, interactions with other organisms, and microbial diseases, treatments and the human immune response will be studied. Three credits.

### **BL 213 Microbiology Laboratory**

Students will learn how to properly handle, grow, and identify microorganisms. Students will study microorganisms in the environment including biofilms, the effect of antibiotics on bacteria, identification of food contaminants, and various factors that contribute to changes in microbial growth. The lab will focus on bacteria. One credit.

### **BL 214 Molecular Genetics**

A detailed study of the interrelationship between the structure and function of nucleic acids and proteins. Seminal experiments serve as a framework to trace the history of molecular biology from early studies on the chemical nature of RNA and DNA and the elucidation of the genetic code to recent investigations of higher order controls of gene expression. The bacterium *E. coli* is a paradigm organism for the examination of universal processes such as transcription, translation, DNA replication, recombination, and gene regulation. Comparisons are then made with analogous functions in eukaryotes. In addition, students are provided with a brief introduction to recombinant DNA methods and biotechnology. Three credits.

### **BL 215 Molecular Genetics Laboratory**

An integrated semester-long laboratory experiment is used to introduce students to the concepts and techniques molecular geneticists employ to elucidate and manipulate gene anatomy. Individual laboratory exercises are dedicated to the cloning, mutagenesis and mapping of a known gene. Sophisticated techniques are then utilized to transfer the mutated gene to a heterologous host, and quantitate its level of expression. Ancillary techniques performed include the extraction of nucleic acids from prokaryotic and eukaryotic organisms, structural characterization of gene fragments by Southern blotting, and computer-assisted analysis of genetic sequences. One credit.

### **BL 216 Biotechnology**

This course engages the blossoming field of biotechnology through

careful dissection of the technologies and their applications. Topics including heterologous protein expression in prokaryotic and eukaryotic systems, the design and production of transgenic plants and animals, stem cell technologies, reproductive and therapeutic cloning strategies, somatic and germline gene therapy approaches, bioremediation, and high throughput screening are examined in detail with consideration given to both their potential and realized industrial, medical, and environmental applications. Emphasis is placed on the technical considerations unique to each technology, although safety and ethical considerations will also be addressed. Offered in even-numbered years. Three credits.

### **BL 217 Biotechnology Laboratory**

This course provides students with significant hands-on experience performing techniques critical to the biotechnology industry. Laboratory exercises involve food biotechnology, biosensor construction, recombinant protein production and purification in both prokaryotic and eukaryotic systems, plant and animal cell structure, gene transfer to cultured plant and animal cells, generation of transgenic plants, and generation of transgenic fruit flies. Must be concurrently enrolled in BL 216 Biotechnology. Offered in even-numbered years. One credit.

## **Organismal Biology**

Study of the structural and physiological characteristics of tissues, organs and organ systems, and their relationships to the organism as a whole.

### **BL 220 Comparative Vertebrate Anatomy**

This course endeavors to provide a comprehensive comparison of vertebrate structure and function in the major body systems. Animals being discussed range from fish to reptiles, to mammals. Human comparisons are also included with each body system. This course is taken concurrently with Comparative Vertebrate Anatomy Laboratory. Three credits.

### **BL 221 Comparative Vertebrate Anatomy Laboratory**

The first part of this course is the comparative analysis of vertebrate skeletal structure. Animals under study include sharks, fish, amphibians, reptiles, birds, and mammals. The second part of the course involves an intensive study of mammalian gross anatomy through dissection of a cat. Body systems to be studied include the muscular, digestive, urogenital, reproductive, circulatory, and nervous systems. One credit.

### **BL 222 Developmental Biology**

This course provides a comprehensive study of vertebrate embryology from fish through mammals. Areas of study include gametogenesis, fertilization mechanisms, early embryological events, and organogenesis. In addition to classical embryology, this course includes instruction on the molecular mechanisms that underlie the various developmental events discussed. Taken concurrently with Developmental Biology Laboratory. Three credits.

### **BL 223 Developmental Biology Laboratory**

A major function of this course is to reaffirm the developmental events discussed in lecture through the examination of slides and models. In addition, this laboratory endeavors to provide students with hands on experience with sterile technique and classical embryological techniques such as vital staining to analyze morphogenic movements, separation of cells to study behavior, and *in vitro* culturing of blastoderms and other embryonic explants. One credit.

### **BL 224 Mammalian Physiology**

Detailed study of organ system function with emphasis on humans. The systems studied include neuromuscular, cardiovascular, respira-

tory, renal, digestive and endocrine. Homeostasis, regulatory mechanisms and the functional relationships between systems are emphasized. Three credits.

### **BL 225 Mammalian Physiology Laboratory**

Hypothesis-driven laboratory experiments designed to explore organ system function in mammals, including humans. Students work extensively with computers to acquire, process and present data. One credit.

## **Population Biology**

Organisms in their relationship to each other and their environment, both historically and presently, form the core of this approach.

### **BL 232 Ecology**

This is a general course emphasizing physical-chemical-biological relationships. Evolutionary trends are considered. Topics include energy relations, biogeochemistry, population growth, and the structure and function of communities and ecosystems. Three credits.

### **BL 233 Ecology Laboratory**

Lab and field experiences paralleling Ecology 232 are designed to teach specific techniques of research design, field sampling, and data analysis in terrestrial and freshwater ecosystems. One credit.

### **BL 234 Evolution and Systematics**

The theory and evidence of the gradual evolution of organisms, and taxonomic relationships of animals and plants. Offered in odd-numbered years. Three credits.

### **BL 235 Evolution and Systematics Laboratory**

Laboratory experiments, computer simulations, and field trips are designed to study concepts presented in BL 234. Offered in odd-numbered years. One credit.

### **BL 236 Biology of Environmental Disturbances**

We will explore the biological aspects of many natural and human-caused disturbances by studying the cellular, physiological and ecological responses of organisms to disturbances such as treefalls, logging, pesticides, acid deposition and drought. The course will focus on ecological problems as well as solutions. Offered in even-numbered years. Three credits.

### **BL 237 Biology of Environmental Disturbances Laboratory**

Laboratory experiments, computer simulations and field work will parallel the topics presented in lecture. Field work will provide data for case studies on disturbances in both terrestrial and freshwater ecosystems. Offered in even-numbered years. One credit.

## **Senior Research Program**

The Senior Research Program introduces students to all facets of developing and completing a research project. It begins with BL 301 where the student writes a research proposal. S/he is introduced to biological literature searches, critical reading of primary research articles, formulation of biologically significant questions, experimental design and long-range planning. The program continues in BL 302 where the student performs the proposed laboratory work. The student masters, adapts and applies laboratory techniques to the solution of specific biological problems. Additionally, the student experiences the excitement of success and the frustration of setbacks common to all research. The program concludes with BL 303 where the student critically analyzes the data, integrates it with the findings of others and presents the work in a written thesis format. Enrollment in the first phase of the program (BL 301) requires completion of General Biology and at least two upper level biology courses, with concurrent registration in a third. Students with a QPA in biology less

than 2.0 or with two or more grades below C in upper level biology lecture courses may not register for BL 301.

### **BL 301 Junior Research Seminar**

Design and plan a research project. Write a research proposal. Two credits.

### **BL 302 Research Project**

Perform the experimental phase of the research project. Prerequisite: BL 301. Two credits.

### **BL 303 Research Thesis**

Write the senior research thesis. Prerequisite: BL 302. One credit.

### **Electives**

#### **BL 242 Histology**

A detailed study of the normal tissues of vertebrates from both a morphological and a functional viewpoint. Special emphasis is placed on the characteristics of human tissues, Students must take the laboratory concurrently. Two credits.

#### **BL 243 Histology Laboratory**

Each student gets experience in the preparation of slides as well as identifying tissues under the microscope. One credit.

#### **BL 248 Environmental Microbiology**

A study of a variety of microorganisms that exist in natural environments, including Antarctica, deep-sea hydrothermal vents, Hot Springs in Yellowstone Park, and sedimentary rock. The possibility of microbial life on the moon will be discussed. The involvement of microorganisms in the flow of energy and cycling of materials will be investigated. Special attention will be given to studying the effect of pollutants on natural microbial populations and the effect of microbiota on environmental contaminants. The application of microbes in the area of bioremediation and bioaugmentation will be presented. May be used to complete a biology minor or counted as an elective for the biology major. Three credits.

#### **BL 249 Environmental Microbiology Laboratory**

Laboratory exercises and field work will be used to introduce students to useful techniques for isolating and examining microorganisms from many different environments, including soil and aquatic environments, and plants and animals. The use of microbes in the area of bioremediation and bioaugmentation will be investigated. May be used to complete a biology minor or counted as an elective for the biology major. One credit.

#### **BL 250 Medical Microbiology**

This course will introduce students to the study of pathogenic (disease causing) microorganisms with a focus on bacteria and viruses. The course will include discussions and lectures and focus on microbial diseases, treatments and prevention, and the human immune response to microorganisms. Three credits.

#### **BL 251 Medical Microbiology Lab**

Students will learn how to properly handle, grow and identify microorganisms. Students will study the effect of antibiotics on bacteria; mutation rates and causes including genetic transfer; and the future of medical microbiology and its importance in the health care setting. The lab will focus on bacteria. One credit.

#### **BL 310 Teaching Biology**

Primarily laboratory instruction which includes lecturing, laboratory preparations and assistance under the supervision of the faculty member in charge of the course. It is not substitute teaching and is intended to provide first-hand experience with the teaching process. Permission of instructor required. One credit.

### **BL 333 Special Study**

The student will pursue a faculty directed course of study. Permission of Chairperson required. Variable credit. May be repeated.

### **BL 350 Independent Research Project**

The student will pursue research distinct from the Senior Research Project. Does not fulfill major or minor credit requirements. Variable credit. May be repeated.

### **BL 550 Cooperative Education — Biology Internship**

Work experience program extending the learning experience beyond the college into the world of work. Students are employed in an area related to their academic endeavor. Academic credits are P/F and are awarded by individual departments according to the extent of the work experience. Students may or may not be paid depending on the site. The purpose of the program is to integrate academic studies and employment activities. Does not fulfill major or minor credit requirements. Variable credit. May be repeated.