

KALAMAZOO COLLEGE  
2017-2018 ACADEMIC CATALOG

## Biology

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The mission of our department and curriculum is to educate students in the field of biology and within the context of a Kalamazoo College liberal arts education. Through our courses, research collaborations, and advising we help each of our students become an intrinsically motivated, self-directed learner who enjoys a biologist's keen awareness of the natural world. Specifically, we foster development of the following attributes in our biology majors: 1) knowledge of the diversity of living organisms and levels - from molecules to ecosystems - at which those organisms can be studied; 2) understanding of how organisms are affected by their evolutionary and developmental trajectories and how these are influenced by environmental contingency; 3) ability to discover new biological knowledge and then communicate it effectively to others; and 4) curiosity about and empathy toward our shared environment.

### Requirements for the Major in Biology

Consonant with the experiential-learning focus of the *K-Plan* and motivated by the biology department mission, our emphasis on an empirical approach to biology creates an environment in which students develop a strong foundation in biology. We encourage our students to ask and seek answers to probing questions, interpret primary literature, design and perform experiments, and make original observations of biological phenomena. The developmental progression from introductory core courses through upper-level electives prepares students well for the challenges of carrying out their Senior Individualized Projects, presenting results of those projects at our annual Diebold Symposium, and then continuing their education or seeking employment after graduation.

#### Number of Units

- A minimum of nine biology courses (five required and four electives) and four cognates exclusive of lab credit, all at C- or better are required to complete a major in biology.
- Among biology electives, at least three must be at the 300 level or higher, two of which must be a lab course. Other than BIOL 112 and BIOL 123, students may not count 100-level courses towards units required for the major.
- Biology majors are encouraged to complete their Senior Individualized Project in biology.
- The biology department will accept for credit in the major a maximum of one unit from the following sources:
  - AP/IB credit (if score on Biology AP exam is 4 or 5, or score on IB exam is 5 or above)
  - Study Abroad course in biology
  - Dual enrollment or transfer course in biology
  - A SIP in biology

#### Required Courses

BIOL 112 Evolution and Genetics with lab  
BIOL 123 Form and Function with lab  
BIOL 224 Ecology and Conservation with lab  
BIOL 246 Cell and Molecular Biology with Lab  
BIOL 490 Functioning as a Biologist

#### Four cognates:

CHEM 110 (Chemical Composition and Structure), CHEM 120 (Chemical Reactivity), and CHEM 210 (Organic Chemistry I) as well as one of the following courses: CHEM 220 (Organic Chemistry II) or MATH 261 (Biostatistics). Because BIOL 246 requires Organic Chemistry as a prerequisite, CHEM 110, CHEM 120, and CHEM 210 must be completed before enrolling in BIOL 246.

#### Comprehensive Examinations

Senior biology majors are required to take a written comprehensive examination as part of BIOL 490.

## Related Concentrations

Students interested in the following concentrations should refer to the full program descriptions and requirements provided in this catalog.

- Biochemistry and Molecular Biology
- Biological Physics
- Community and Global Health
- Environmental Studies
- Neuroscience

## Biology Courses for Nonmajors

All biology courses at the 100 level are open to nonmajors without prerequisite. Courses we offer for nonmajors have goals consistent with those for the biology curriculum focused on majors. To attain those goals, general education courses directed primarily at students not majoring in biology should help students:

- Appreciate, understand, and engage in the process of doing science.
- Evaluate validity of scientific communications. For example, our students should be able to read, understand, and evaluate any *New York Times* article, especially those in the Tuesday Science Times.
- Be comfortable with ambiguity and uncertainty.
- Learn that science is a fascinating human endeavor, applicable to everyday life.

## Biology courses

### **BIOL 112 Evolution and Genetics with Lab**

An introduction to principles of evolution and genetics. Includes a comprehensive overview of genetics from molecular, classical, and population perspectives, as well as in-depth treatment of evolutionary mechanisms, phylogenetic analysis, and the history of life on Earth. Laboratories include the purification and analysis of DNA, *Drosophila* and bacterial genetics, computer and class simulations of evolutionary processes, and bioinformatics.

### **BIOL 115 Environmental Science**

In this course you will (1) build a basic understanding of the physical and natural systems that make up the biosphere on Earth (land, water, atmosphere, and life) stressing the dynamics of these interconnected systems; (2) develop a scientific understanding of the causes and consequences of several of the major environmental problems facing today's society; (3) acquire the tools to enable you to think critically about other current and future environmental challenges you will face as a member of contemporary society. One weekend field trip is required. Intended for non-majors and as an entry to the Environmental Studies Concentration.

### **BIOL 123 Form and Function with Lab**

Organism-level phylogeny, morphology, and physiology are the major subject areas of this course; organisms interacting with, and adapting or adjusting to, their environments is the underlying theme running through these subject areas. Through this course students will learn how the environment, biotic and abiotic, shapes the form (morphology) and function (physiology and behavior) of organisms over ecological and evolutionary time.

### **BIOL 200 Research Apprenticeship in Biology**

Apprenticeships intended to provide opportunities for biology majors to become regularly involved in ongoing research projects with faculty, either with the same faculty member for a number of quarters or with different faculty in different quarters. A minimum of 50 hours of work is expected for each quarter. Three apprenticeships earn one full unit toward graduation.

### **BIOL 222 Vertebrate Biology with Lab**

Broad-based study of comparative anatomy and life histories of adult vertebrates and how these influence our understanding of vertebrate phylogeny; laboratories in comparative anatomy and diversity of vertebrates.

*Prerequisite: BIOL-123 All course prerequisites must be met with a minimum grade of C-.*

### **BIOL 224 Ecology and Conservation with Lab**

Ecology is rooted in natural history, the description of organisms in their environments. Ecologists study interactions in nature across many levels of biological organization, from individuals to populations, communities, ecosystems, and, finally, the entire biosphere; this course is organized along this continuum. How do we explain the distribution and abundances of

organisms? How do populations of different species interact as competitors, as predators and prey, as pathogens and hosts, and as mutualists? And finally, given the planet-wide environmental impact of our species, how can ecologists apply their knowledge to the conservation of natural resources?

*Prerequisite: BIOL-123 All course prerequisites must be met with a minimum grade of C-.*

### **BIOL 232 Plant Biology with Lab**

In this course we will explore the consequences of being a plant: they make their own food; generally they are stuck in one place; they are as dumb as posts; they are modular; they have some very cool genetics; they have evolved some critically important symbioses with bacteria and fungi. Moreover, plants can live without us, but we cannot live without them. We will review the plant kingdom generally, but we will focus on the angiosperms (flowering plants), covering broad aspects of structure, development, growth, and reproduction. Laboratory will focus on field identification and ecology.

*Prerequisite: BIOL-123 or Permission All course prerequisites must be met with a minimum grade of C-.*

### **BIOL 246 Cell and Molecular Biology with Lab**

The complex workings of individual cells will be explored from a molecular perspective. Topics include the flow of genetic information, cell structure and mechanics, metabolism, cell signaling, and regulation. An integrated laboratory will introduce cutting-edge cell and molecular techniques, including cell culture, transfection, immunoprecipitation, electrophoresis, and Western blotting.

*Prerequisite: BIOL-112 and CHEM-210 All course prerequisites must be met with a minimum grade of C-.*

### **BIOL/PSYC 290 Animal Behavior with Lab**

The study of animal behavior seeks to describe and explain behavior on multiple levels - from underlying physiological causation to evolutionary origin. Using examples from barnacles and worms to birds and mammals, this course examines behaviors such as orientation, communication, foraging, territoriality, reproduction and sociality. Through lectures, research literature and laboratory studies students will build proficiency in designing, conducting, analyzing and evaluating behavioral studies and gain new appreciation for the subtlety and complexity of behavior and its application to fields such as animal welfare and conservation.

*Prerequisite: BIOL-112, or BIOL123, or PSYC-101 All course prerequisites must be met with a minimum grade of C-.*

### **BIOL 295 Computational Tools for Biologists**

Students progress through the biology major at K learning about many laboratory tools that biologists use to perform research. One tool that is essential for modern biologists is the personal computer. Simply put: modern biology research requires a working knowledge of computers and scripting. This course introduces students to their personal computer and teaches them the possibilities of basic shell use, scripting (with the Python language), simple relational database creation and use, and basic graphics manipulation in a practical, problem-based framework. This course aims to help sophomores/juniors learn these skills in preparation for their SIP research and future biology research.

*Prerequisite: BIOL-112 and BIOL-123 or permission of instructor*

### **BIOL 312 Population and Community Ecology with Lab**

This course builds upon principles studied in BIOL 224. Using both theoretical and empirical approaches, we will explore in greater depth: population ecology, demography, life history strategies, species interactions, community structure and dynamics for both aquatic and terrestrial communities. Labs will focus on the methods ecologists use to answer questions about the distribution and abundance of organisms; students will explore local habitats and conduct independent research.

*Prerequisite: BIOL-224 All course prerequisites must be met with a minimum grade of C-.*

### **BIOL 322 General and Medical Microbiology with Lab**

This course includes a general introduction to microbiology including the structure and function, metabolism, and genetics of bacteria, archaea, viruses, and eukaryotic microbes. This basic introduction is expanded by topics including the roles of microorganisms in biogeochemical cycling, food microbiology, the pathogenesis of infectious diseases, and the benign and beneficial role that microorganisms play in the human body. Labs will focus on using standard microbiological techniques (e.g. sterile technique, dilution and culture-dependent assays, microscopy, molecular and computational biology) as tools for inquiry-based explorations of the microbial world.

*Prerequisite: BIOL-246 All course prerequisites must be met with a minimum grade of C-.*

### **BIOL 350 Neurobiology with Lab**

Structure and function of the nervous system will be considered, in addition to the molecular and cellular workings of individual neurons. Topics include cell biology of neurons, electrophysiology, sensory and motor systems, brain development, and dysfunction of the nervous system. An integrated laboratory will focus on neuroanatomy, histology, physiological simulations, and neuronal cell culture.

*Prerequisite: BIOL-246 or Permission All course prerequisites must be met with a minimum grade of C-.*

### **BIOL/CHEM 352 Biochemistry with Lab**

Overview of the chemical mechanisms underlying biological processes including structure and function of proteins, polysaccharides, and lipids; enzymatic catalysis and kinetics; an introduction to bioenergetics; detailed treatment of

carbohydrate metabolism; survey of lipid and amino acid metabolism; and integration of metabolism. Laboratory will emphasize enzyme kinetics, protein isolation, and electrophoresis.

*Prerequisite: CHEM-220 or CHEM-224 All course prerequisites must be met with a minimum grade of C-.*

### **BIOL/CHEM 352 Biochemistry**

Overview of the chemical mechanisms underlying biological processes including structure and function of proteins, polysaccharides, and lipids; enzymatic catalysis and kinetics; an introduction to bioenergetics; detailed treatment of carbohydrate metabolism; survey of lipid and amino acid metabolism; and integration of metabolism. Prerequisite: CHEM-220. All course prerequisites must be met with a minimum grade of C-.

*Prerequisite: CHEM-220 All course prerequisites must be met with a minimum grade of C-.*

### **BIOL/CHEM 352L Biochemistry Lab**

Overview of basic biochemical laboratory techniques with emphasis on protein isolation and characterization, enzyme kinetics, and bioinformatics. Students will devise and execute independent research projects as part of the course final project. Laboratory and scientific writing, oral communication, and preparation of quality figures and tables will also be emphasized. Prerequisites: CHEM-220 and CHEM/BIOL352 (can be taking concurrently). All course prerequisites must be met with a minimum grade of C-.

*Prerequisite: CHEM-220, Minimum grade of C- CHEM/BIOL-352 Lecture must be taken previously or concurrently*

### **BIOL 360 Immunology and Human Health with Lab**

Introduction to basic principles of the mammalian immune system, including recognition of pathogens, mechanisms of pathogen clearance, the regulation of immune cells, and the evolution of immunity. We will explore current topics in immunology and human health, including personalized medicine, the rise of autoimmune diseases, and the cost of health care. Labs will cover both experimental infection models (e.g. nematodes) and molecular techniques in immunology (e.g. nucleic acid analysis).

*Prerequisite: BIOL-246 All course prerequisites must be met with a minimum grade of C-.*

### **BIOL 376 Human Physiology with Lab**

This course explores the functioning and regulation of the human body. We will cover a variety of body systems as well as relevant emerging fields (e.g., evolutionary medicine). Emphasis will be placed in unifying themes (integrative physiology, homeostasis and the external environment, the role of evolution in shaping human physiology). Laboratories will include student-led experiments, primary literature discussions, presentations, and case studies.

*Prerequisite: BIOL-123 All course prerequisites must be met with a minimum grade of C-.*

### **BIOL 396 Entomology with Lab**

A comprehensive introduction to the biology and classification of insects. Topics covered include insect structure, function, development, behavior, principles of control, identification, systematics, and evolution. Laboratories include field trips to local sites to observe and collect insects, and to view ongoing basic and applied research projects by local entomologists. Students will gain experience in rearing and handling insects. All are required to assemble a collection of local insects.

*Prerequisite: BIOL-123 and BIOL-224 All course prerequisites must be met with a minimum grade of C-.*

### **BIOL 420 Advanced Molecular Genetics W/ Lab**

Advanced treatment of principles and methods of modern molecular genetics. Building on principles from core biology courses, this course covers multiple perspectives on genetics, including gene structure and regulation, modes and patterns of inheritance, identification and manipulation of specific genes, as well as population and quantitative genetics. Laboratories feature classical and molecular approaches including gene mapping with *Drosophila*, PCR and sequencing-based human genotyping, and accessing and utilizing bioinformatics databases.

*Prerequisite: Take BIOL-112 and BIOL-246 All course pre-requisites must be met with a minimum grade of C-.*

### **BIOL 484 Topics in Biology: Neurodegenerative Disorders**

The molecular underpinnings of nervous system disease and injury states will be investigated. A combination of lectures, discussions, and student presentations of research articles will be employed. Course readings will come exclusively from the primary literature. Topics covered will include neurodegenerative diseases, nervous system injury states, drug addiction, and brain tumors.

*Prerequisite: BIOL-246 All course prerequisites must be met with a minimum grade of C-.*

### **BIOL 485 Topics in Biology: Trees**

This course focuses on how trees impact human welfare and influence the environment. We will examine tree structure, physiology and ecology. We will discuss how conventional and urban forests are managed, how fire and climate change influence tree growth and regeneration, and how forests could provide climate change mitigation. We will also examine how trees impact social behavior and provide ecosystem services. Students will discuss current peer reviewed and popular press literature. The class will be discussion, lecture and field based. Students will experience activities that will enhance their understanding and appreciation of trees on campus and at the Lillian Anderson Arboretum.

### **BIOL 486 Animal Development and Evolution**

This course will explore the developmental and evolutionary basis of the morphological biodiversity of animals. Topics will include the fundamental pathways by which cells, tissues, organ systems and body plans develop, and how those pathways are modified during evolution. The course will integrate multiple levels of biological organization, ranging from molecular genetics, to cell biology, to organismal biology. Emphasis will be placed on reading and analysis of primary literature.

*Prerequisite: Must have previously taken BIOL-112; BIOL-123; BIOL-224 BIOL-246; All course prerequisites must be met with a minimum grade of C-.*

#### **BIOL 488 Topics in Biology: the Symbiotic Habit**

A comprehensive overview of current symbiosis research literature, focusing on animal-microbe relationships and with special emphasis on the human microbiome. This course will highlight both model- and non model-based approaches for understanding topics ranging from molecular biology to ecology and symbiotic relationships. Students will be responsible for reading primary literature and participating in discussion, oral presentations, and concise scientific writing.

*Prerequisite: BIOL-112, BIOL-123, BIOL-224, and BIOL246 All course prerequisites must be met with a minimum grade of C-.*

#### **BIOL 489 Topics in Biology: Chemical Ecology**

Chemical ecology uses an evolutionary framework to understand the origin, function and significance of the chemistry underlying biological interactions. Through lectures, reading, discussion, student presentations and hands-on exercises we will explore how a diversity of life forms synthesize, use and respond to naturally-produced chemicals at the molecular through ecosystem level. Topics will be investigated from both basic and applied perspectives and include chemical ecology of defense, aggregation, feeding, mating, social interactions and deceit.

*Prerequisite: Must have previously taken BIOL-112, BIOL-123, BIOL-224, BIOL-246 and CHEM-210; All course prerequisites must be met with a minimum grade of C-*

#### **BIOL 490F Senior Seminar (Full Year)**

Participation in a seminar involving teaching and research in the literature and consideration of current biological questions; preparation for SIP research through literature search and critical discussion of pertinent papers; preparation and defense of completed thesis based upon SIP research. (Fall component of full-year course.)

*Prerequisite: Senior Standing*

#### **BIOL 490S Senior Seminar (Full Year)**

Participation in a seminar involving teaching and research in the literature and consideration of current biological questions; preparation for SIP research through literature search and critical discussion of pertinent papers; preparation and defense of completed thesis based upon SIP research. (Spring component of full-year course.)

*Prerequisite: Take BIOL-490F and BIOL-490W and Seniors Only*

#### **BIOL 490W Senior Seminar (Full Year)**

Participation in a seminar involving teaching and research in the literature and consideration of current biological questions; preparation for SIP research through literature search and critical discussion of pertinent papers; preparation and defense of completed thesis based upon SIP research. (Winter component of full-year course.)

*Prerequisite: Take BIOL-490F and Senior Standing*

#### **BIOL 593 Senior Individualized Project**

Each program or department sets its own requirements for Senior Individualized Projects done in that department, including the range of acceptable projects, the required background of students doing projects, the format of the SIP, and the expected scope and depth of projects. See the Kalamazoo Curriculum -&gt; Curriculum Details and Policies section of the Academic Catalog for more details.

*Prerequisite: Permission of department and SIP supervisor required.*

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