Biology

Professors: Fraser (Chair), Girdler, Langeland, Martinez Peña y Valenzuela, Moore, Salinas, Sundararaj, A. Wollenberg, M. Wollenberg

The mission of our department and curriculum is to educate students in the field of biology and foster a community of learning and practice. Our approaches are embedded in the context of a Kalamazoo College liberal arts education. Through our courses, research collaborations, advising, and departmental experiences, we help all students find their place in science and develop a biologist’s keen awareness of the natural world. Specifically, our goal is that all students who participate in Biology will:

1) feel curious about the natural world and empathetic toward our shared environment;

2) know what has been discovered about the natural world, the process by which such knowledge is gained, and how to evaluate competing claims;

3) identify as new members of an interdependent community whose goal is to address socially relevant problems and questions; and

4) continually apply/practice newfound knowledge and skills via career exploration, problem solving, research, communication, and teamwork.

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 Integrated Projects, presenting results of those projects at our annual Diebold Symposium, and then continuing their education or seeking employment after graduation.

A minimum of nine biology courses (five required and four electives) and three cognates exclusive of lab credit, all at C- or better are required to complete a major in biology. None of these courses may be completed Credit/No Credit.

A. Biology Core Requirements:

- Evolution and Genetics with Lab - BIOL 112
- Form and Function with Lab - BIOL 123
- Ecology and Conservation with Lab - BIOL 224
- Cell and Molecular Biology with Lab - BIOL 246
- Senior Seminar - BIOL 490 (partial credit portions spread across Fall, Winter and Spring terms during senior year)

B. Elective courses:

A minimum of four biology electives are required to complete the major in biology. All except Course 1 must be taught by a Kalamazoo College faculty member. Eligible electives are as follows and may be completed in any order:

- Course 1: course at 200-level or above, or one unit from the following outside sources:
  - One unit from a 2 unit biology research SIP with thesis
- Study Abroad course in biology
- Dual enrollment or transfer course in biology

- Course 2: lab course at 300-level or above
- Course 3: lab course at 300-level or above
- Course 4: lab or non-lab course at 300-level or above

Biology majors are encouraged, but not required, to complete their Senior Integrated Project in biology.

C. Three cognates:

**Natural Basis of the Living World:** Biology rests upon foundations created by other natural sciences; all Biology majors will engage with another STEM discipline.

One unit from any of the following departments/programs:

- Chemistry
- Computer Science
- Environmental Science
- Mathematics
- Physics

**Human Context of Biology:** Biology is a human enterprise, and the conduct and interpretation of science depend on much broader contexts. Our majors will engage with material in the social sciences and humanities in order to better understand these broader, social contexts.

One unit from any of the following departments/programs:

- Anthropology and Sociology
- Classics
- Community and Global Health
- Critical Ethnic Studies
- Economics and Business
- History
- Philosophy
- Political Science
- Psychology
- Religion
- Women/Gender/Sexuality

**Modes of Expression:** Biology has a strong aesthetic component—from how we appreciate and measure nature, to how we communicate our findings and inspire others to learn. In order to enhance and deepen these connections, our majors will engage with the arts and literature.

One unit from any of the following departments/programs:

- Art/Art History
- English
- Music
- Studio Art
- Theater Arts

**Graduate and Professional Program Preparation**

Certain career tracks in biology, including medical, professional, and graduate schools, may require additional courses from
other departments. For example, most medical schools require applicants to have taken Physics and Organic Chemistry, and many graduate programs in organismal and ecological biology require Biostatistics. Majors should consult with the Director of Careers in Health and Medicine and/or a member of the Biology Department when planning courses.

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

**FAQs:**

*Can AP/IB units count as biology electives?*
No. AP/IB biology credit no longer counts toward the biology major but may receive general college elective credit if the exam score meets college criteria.

*Can AP/IB units, or transfer units, count as cognates?*
No.

*Can one class fulfill multiple biology cognates?*
No. If a course is cross-listed between two cognate areas, students may choose which single cognate it fulfills. This choice can be changed retroactively.

*Can partial units be combined to count as a cognate?*
No.

*Can classes taken on study abroad fulfill cognate requirements?*
Yes. If a study abroad course is already accepted by an on-campus department or program as part of its requirements, then that course can be counted as taken in that department or program.

**Requirements for the Concentration in Biochemistry**

Directors: Stevens-Truss (contact person), Langeland, Moore

A major focus of modern scientific inquiry is uncovering the physical and chemical mechanisms underlying biological systems. Therefore, an interdisciplinary concentration in Biochemistry and Molecular Biology is offered for students interested in advanced study at the interface between biology and chemistry. Courses include a selection from the physical and biological sciences, all offered with labs that make use of sophisticated, cutting-edge instrumentation and techniques. Students interested in graduate studies of molecular-level biological phenomena are especially encouraged to consider this plan of study.

**Required Courses**
In Biology:
BIOL 246: Cell and Molecular Biology with Lab
BIOL 352: A Survey of Biochemistry (note: same as CHEM 352, need only do one)
BIOL 352L: Intro to Biochemical Analyses

In Chemistry:
CHEM 220: Organic Chemistry II with Lab
CHEM 310: Physical Chemistry I with Lab
CHEM 352: A Survey of Biochemistry (note: same as BIOL 352, need only do one)
CHEM 352L: Intro to Biochemical Analyses

One additional course in Biology or Chemistry – choose either:
BIOL 420: Advance Molecular Genetics with Lab, or
CHEM 46052: Advanced Biochemistry with Lab

In Mathematics:
MATH 112
In accordance with College policy, concentrators in biochemistry and molecular biology must pass the required courses with a C- or better.

**Note:** Students cannot earn a major in Biochemistry and complete a concentration in Biochemistry and Molecular Biology.

### Additional Related Concentrations

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

- 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 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/ENVS 195 Special Topic: Science and Social Justice**
Why does anyone become a scientist? What problems do you want to solve? This course is intended for first year students who are interested in exploring the STEM fields (Science, Technology, Engineering and Mathematics) and also want to empower their communities to address some of society's most vexing problems. We will take an interdisciplinary scientific approach to issues such as lead in pipes and paint, sinking coastal cities, contested genomes, and conflicts between technology and culture. At the same time we will necessarily confront intersecting ethical and social factors that set the context for these issues, such as race, gender, citizenship status, colonial history, and access to healthcare and education. No prior knowledge of any scientific discipline is required to be successful in this course, although we will be doing science. Note: You must co-enroll in the laboratory section of this course.

**BIOL 198 Independent Study**

**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 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:** One of the following courses: BIOL-112, BIOL123, PSYC-101 All 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. All pre-requisites must be met with a grade of C- or better.

**BIOL 295 Human Anatomy w/ Lab**
This course is intended as an introduction course in Human Anatomy. It is designed to provide a strong foundation in human anatomy to pre-health students in health-oriented, medical, and biological disciplines. In order to enhance this knowledge, students will be exposed to anatomic terminology. The subject matter includes musculoskeletal systems, axial and appendicular skeleton, nervous system, respiratory system, cardiovascular system, digestive system, urinary system, reproductive system, and male and female reproductive system. We will use Visible Body Courseware as a comprehensive online learning platform packed with the most advanced immersive 3D learning content on the human body.

**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 of instructor All course prerequisites must be met with a minimum grade of C-.

**BIOL/CHEM 352 A Survey of 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; Biology majors only All course prerequisites must be met with a minimum grade of C-.

**BIOL/CHEM 352L Intro to Biochemical Analyses**
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.

**Prerequisite:** CHEM-220, Minimum grade of C- CHEM/BIOI-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-224 or BIOL-246 with a minimum grade of C-.

**BIOL 395 Plant-Animal Interactions**
Throughout their 500 million years of shared evolutionary history, plants and animals have interacted as antagonists and mutualists. We will explore that history by examining major forms of interaction (herbivory, pollination, seed dispersal, and protection); how these interactions shape the chemistry, physiology, behavior and life history of interacting partners; how
these interactions have helped generate the diverse life forms we see today; and why these interactions are vital to maintaining functioning ecosystems. We will use lecture/student presentations, discussion of scientific and lay audience literature, and hands-on observation, experimentation and service to explore the theory, practice and application of plant-animal interaction studies.

Prerequisite: BIOL-224 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-224 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: BIOL-246 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 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.

Prerequisite: BIOL-224 and BIOL-246 with a minimum grade of C-.

BIOL 486 Topics in Biology: Animal Development &amp;
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: BIOL-224 and 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-224 and BIOL-246. 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: BIOL-224 and BIOL-246. 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: Biology Major and 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:** Biology Major, Senior Standing, and take BIOL-490F and BIOL-490W.

**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:** Biology Major, Senior Standing, and take BIOL-490F

**BIOL/CGHL 495 Topics in Biology: SARS-CoV-2 & COVID19**

2020 has been defined by a global pandemic caused by the virus SARS-CoV-2. This course examines the biology, origin, and spread of SARS-CoV-2 and epidemiology and public health responses to COVID19. In this course, students will use both peer-reviewed scientific publications and more general literature (e.g. news articles, non-profit publications, statistical websites) to better understand the biology of SARS-CoV-2 and its effects on individuals and populations. Students will be responsible for demonstrating their learning with an exam, oral presentations to the class, and a multi-week, multi-part, written assignment.

**Prerequisite:** BIOL-224 and BIOL-246 with a minimum grade of C-.

**BIOL 495 Topics in Biology: Evolutionary Ecology**

Evolutionary ecology lies at the intersection of ecology and evolution: it seeks to explain the ecology of organisms in the context of evolution and patterns of evolution as explained by ecological processes. In this course, we will discuss theoretical/synthetic and empirical studies so that young biologists gain a solid foundation on evolutionary ecology. Assessment will consist of written assignments and the effective leadership of discussions.

**Prerequisite:** BIOL-224, and BIOL-246 with junior or senior standing. All pre-requisites must be met with a minimum grade of C-.

**BIOL 495 Synaptopathy: Synapse Dysfunction**

This course focuses on synaptic dysfunction known as synaptopathy. Optimal synaptic communication is crucial for proper skeletal muscle physiology (peripheral synapses) and brain physiology (central synapses). Many psychiatric disorders like schizophrenia or autism have been related to synaptic disturbances. Likewise, neurodegenerative diseases such as Amyotrophic Lateral Sclerosis, Alzheimer's disease and Parkinson's disease are characterized by disrupted synaptic structure and function. In this course students will read, discuss and present on contemporary research literature in the field to gain an understanding of the synaptic role in neurodegenerative and psychiatric disease, and the origins of resulting synaptopathies.

**Prerequisite:** BIOL-246 with a minimum grade of C-.

**BIOL 593 Senior Integrated Project**

Each program or department sets its own requirements for Senior Integrated 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; Senior Integrated Project section of the Academic Catalog for more details.

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

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