

# BIOLOGY

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From the molecules that are the building blocks of life to the complex interactions between living organisms and their environments, biology continues to fascinate the human mind. The Biology Department offers a diverse array of courses and experiences that present fundamental biological principles and processes within the context of being informed, responsible, and compassionate citizens. It provides a broad range of learning opportunities through its course offerings, laboratories, independent study/research, internships, and off-campus study programs at sites including South India, The Bahamas, Central and South America, and Australia. Woven into all learning opportunities are hands-on experiences with modern equipment that stimulate critical and independent thinking.

For science majors, the Biology Department offers an exciting slate of challenging and rewarding courses. For the less science-oriented student, it seeks to stimulate natural curiosity about how our bodies work and how humans interact with their surroundings by providing several courses designed primarily for non-science majors. These courses, which satisfy the natural sciences (SED, IST) requirements of the general education curriculum, focus on current biological issues and general interest topics in biology.

## Overview of the Major

The ever-broadening nature of biology requires diversely trained and inquisitive biologists. The biology major has the dual mission of introducing students to the information and technological tools of various disciplines of biology while instilling the confidence to critically assess a biological phenomenon and to design and carry out an appropriate research program. To that end, the biology major provides the necessary content and instrument training while students practice the art of scientific inquiry. Opportunities for interdisciplinary work abound. Biology majors are encouraged to participate in research with faculty, off-campus programs in biology, departmental seminars, and social activities.

## Intended Learning Outcomes for the Major (<http://wp.stolaf.edu/curriculum-committee/biology-major-ilos>)

### Distinction

See Academic Honors (<http://catalog.stolaf.edu/archive/2016-2017/academic-regulations-procedures/academic-honors/#distinction>)

The Biology Department honors a limited number of graduating majors with distinction in biology. In early fall, eligible biology seniors may apply for distinction. Evaluation of candidates occurs in the spring semester. More information is available on the biology website (<http://wp.stolaf.edu/biology/distinction>).

## Special Programs

Research opportunities and other independent study are central to the teaching mission of the Biology Department. Full-credit course opportunities include independent study (BIO 298), independent

research (BIO 398), and directed undergraduate research (BIO 396). BIO 291 is a 0.25 credit opportunity for a journal club or other exploratory course offered at student request and the professor's discretion. BIO 375 is a 0.25 credit course option for students completing a research project or piloting a new project. Each summer, many biology faculty participate in CURI (<http://wp.stolaf.edu/curi/summer-undergraduate-research>) summer research in which paid ten-week positions offer excellent opportunities for students in lab, field, and computer-based research.

The Biology Department offers many opportunities for off-campus study. Two semester-long programs, Biology in South India (offered every fall semester) and Environmental Science in Australia (usually offered alternating spring semesters), are of particular interest to biology students. Other semester/summer programs are available through affiliated institutions or programs (e.g., ACM Oak Ridge Science Semester, ACM Tropical Field Research, Coe College Wilderness Field Station, Denmark's International Studies Program). In addition, each Interim several off-campus biology courses are offered; see courses marked "off-campus" or "abroad" in the course list below. Students interested in off-campus biology courses should consult biology faculty or the Office of International and Off-Campus Studies (<http://wp.stolaf.edu/international>).

Several concentrations are offered that closely relate to the Biology Department: biomolecular science, environmental studies, mathematical biology, neuroscience, and statistics. Students interested in these concentrations should consult the descriptions in this catalog or the program director.

## Requirements

### General Requirements for the Major

All students majoring in biology complete eight biology courses and a year of chemistry (CHEM 121, CHEM 123, CHEM 126; or CHEM 125, CHEM 126; or CH/BI 125, CH/BI 126). Note that CHEM 126 and CH/BI 126 have a prerequisite of completion of one calculus course.

### Major Requirements

**Biology courses (explained in more detail below this table)**

Foundation course

At least one course from each of four core categories

At least one level III biology course

Two elective courses

#### Chemistry

Select one of the following sequences (CHEM 126 and CH/BI 126 require completion of a calculus course):

CHEM 121 & CHEM 123 & CHEM 126	General Chemistry and Atomic and Molecular Structure and Energies and Rates of Chemical Reactions
CHEM 125 & CHEM 126	Structural Chemistry and Equilibrium and Energies and Rates of Chemical Reactions

CH/BI 125 & CH/BI 126	Integrated Chem/Bio I: Chemical Concepts with Biological Applications and Integrated Chem/Bio II: Thermodynamics and Kinetics with Bio Relevance
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## Foundation Course

The biology major begins with BIO 150. This course explores the evolutionary and genetic foundations of life's biodiversity, and establishes the laboratory and scientific communication skills upon which subsequent courses build. AP or IB credit does not provide the equivalent of this foundation course; students with AP or IB credit instead receive one 100-level elective credit in the major. Students planning to major in biology should take this foundation course first; students who decide to switch to a biology major should take this foundation course at the time of deciding their major.

## Core Categories

Students must take one course from each of the four core categories listed below. While the categories below are listed in order of biological level of organization, students may take their upper-level biology courses in any order providing that prerequisites are met. Please consult the course descriptions to see the prerequisites for each course.

1. **Genetics.** Genetics examines relationships between genotype and phenotype in prokaryotic and eukaryotic organisms from classical and molecular perspectives. Through a course in this category, students will explore gene structure, inheritance, and expression. Through genetics, students discover the ways in which the field of genetics is interdisciplinary, research-based, and relevant to the world today. Course: BIO 233
2. **Cell Biology.** Cells are the basic units of life, and understanding the structure and function of cells, and how they are studied, is central to understanding modern biology. Through a course in this category, students will obtain a comprehensive overview of cellular structure and function, for example cellular compartments, macromolecular structures, and life processes such as energy and material flux, cell division, and control mechanisms. Courses: either BIO 227 or CH/BI 227 (taken as part of the year-long CH/BI sequence)
3. **Comparative Organismal Biology.** Courses in this category study life at the tissue, organ system, and individual levels of organization. Students will broaden their knowledge of a group of organisms (e.g., plants) or of a universal biological phenomenon (e.g., reproduction). Courses in this category approach the content through comparisons across multiple taxa. Courses: BIO 242, BIO 247, BIO 248, BIO 251, BIO 252, BIO 266, BIO 275, or participation in the Environmental Science in Australia (<http://wp.stolaf.edu/environmental-studies/environmental-science-in-australia-2>) semester (but this program cannot count for both the Comparative Organismal and the Ecology core requirements)
4. **Ecology.** Ecology is the study of the interactions between organisms and their environments. These interactions are studied at levels of biological organization from individuals to populations, communities, ecosystems, landscapes, and the entire biosphere. Through ecology, students can better understand interconnections in the natural world, and become more aware of their role in sustaining the biodiversity and ecosystem services

that benefit all life on earth. Courses: BIO 261 or participation in the Environmental Science in Australia (<http://wp.stolaf.edu/environmental-studies/environmental-science-in-australia-2>) semester (but this program cannot count for both the Comparative Organismal and the Ecology core requirements)

## Level III Biology Course

Every biology major takes at least one level III course in the department. Our level III course offerings vary greatly in topic and in type of student work, yet they all share aspects such that each student has an opportunity to experience sophisticated, independent, iterative work in biology. Students in a directed research course will practice sophistication in experimental design and practice, independence in their investigation, and iterative troubleshooting. Students in a non-laboratory investigative course will practice sophistication in evaluating the primary literature, as well as independence in assembling and synthesizing ideas from that literature. Not all level III biology courses meet this requirement. Specifically, BIO 394 does not count toward the biology major, and any 300-level courses worth less than a full credit (BIO 375, and any 0.5 credit BIO 396 courses) cannot fulfill the Level III requirement. Sometimes Level III topics courses in other departments like Environmental Studies can count as the Level III biology course. Students should consult catalog descriptions for each level III course to learn about the topic, type of student work, and prerequisites.

## Elective Courses

Students complete their biology major with two elective courses. Any full credit (1.00) biology course can count as an elective with the following exceptions:

- Only one independent study (BIO 298) and one independent research (BIO 396 or BIO 398) can count toward the major.
- Internships (BIO 294 or BIO 394) do not count toward the major. BIO 294 and BIO 394 can only be taken P/N.

In addition to courses designated as biology, the St. Olaf courses in the table below can count as biology electives:

CHEM 379	Biochemistry I	1.00
NEURO 239	Cellular and Molecular Neuroscience	1.00
PSYCH 238	Biopsychology	1.00
ENVST 281	Topics in Environmental Studies (when topic includes appropriate biology content)	1.00

## General Considerations for the Major

- No more than two level I biology courses, including BIO 150, and AP or IB credit may count toward the major.
- Of the six courses counting toward the major that must be graded C or above, at least four must be at level II or III.
- Students wishing to count for the major a course taken abroad or at another institution must consult with the chair for approval before taking the course.
- While programs leading to graduate work are planned on an individual basis, many programs require students to have completed two or more quantitative courses (mathematics, statistics, or computer science), two courses in physics, and at least four courses in chemistry. Students intending to enter graduate

or professional school are encouraged to consult with the biology faculty to plan a course of study appropriate for the postgraduate program.

- Students pursuing a secondary school science education teaching license with a life science specialty should consider completing the biology major including BIO 123 or BIO 243 as one of their electives. Additional courses are required as specified by the Education Department. Interested students should consult faculty in the Education Department.
- All of the level II and III courses in biology have prerequisites. Please consult the course descriptions for this information.

## Courses

### **BIO 110: Supplemental Biology (0.25)**

This biology course emphasizes learning strategies and critical thinking skills as applied to the curriculum of BIO 150. Objectives of the course are met through additional readings, problem sets, brief written assignments, introduction of discipline-specific writing styles, projects (including individual and/or group oral presentation), and library research. Assignments include new content that complements introductory biology. P/N only. Offered annually.

**Prerequisites:** concurrent enrollment in BIO 150 and permission of instructor.

### **BIO 121: Biological Science: Issues in Biology**

This course explores contemporary biological issues related to health and the environment, with the goal of fostering informed citizens prepared for current biological debates. Students learn relevant biological principles in lecture and lab followed by appropriate lab or field research. Specific topics vary from year to year and may include emerging diseases, cardiovascular health, genetics, specific groups of organisms, behavior, and environmental dynamics. The course includes lectures plus one two-hour laboratory per week.

### **BIO 123: Human Biology**

This course focuses on the wondrous actions of the human body. Students learn how several vital body functions occur subconsciously, such as the rhythmic beating of the heart or the digestion of nutrients after a meal. Topics include how the brain works, how muscles contract, and how kidneys produce urine, and the remarkable biology associated with reproduction. Students use this understanding to elucidate diseases such as diabetes and hypertension. Students attend class plus one two-hour laboratory per week. Offered annually.

### **BIO 124: The Biology of Women**

Issues of women's biology including views of the evolving female and biological determinism are examined. Core material covers anatomy, development, the biological basis of gender, reproduction, sexual response, the menstrual cycle and aging, and aspects of women's health such as eating disorders, cancers, and hormonal treatments. Students participate in significant amounts of group work and oral presentation. The course is open to both men and women. Offered during Interim. Counts toward women's and gender studies major and concentration.

### **CH/BIO 125: Integrated Chem/Bio I: Chemical Concepts with Biological Applications**

This course introduces chemical concepts that are important for students pursuing a study of chemistry or biology. Topics include atomic structure, the periodic table, bonding interactions within and between particles, water and its solutions, biological membranes, chemical reaction types, chemical stoichiometry, equilibrium systems, acids and bases, introduction to protein structure. Examples are often pulled from the realm of biological molecules and processes. Students attend three classes and one three-hour laboratory each week. Placement via online placement exam is required. Offered annually in the fall semester.

**Prerequisites:** high school biology, chemistry, and physics; concurrent registration in MATH 119 or MATH 120 is recommended.

### **CH/BIO 126: Integrated Chem/Bio II: Thermodynamics and Kinetics with Bio Relevance**

This course introduces physical chemistry with an emphasis on thermodynamics and kinetics of biologically relevant systems. Topics include probability as the driving force for chemical reactions; the relationship between chemical bonding energetics, entropy, and equilibria; oxidation-reduction reactions and electrochemistry; and rates of reactions, including enzyme-catalyzed reactions. Laboratory experiments and activities illustrate lecture topics and introduce new concepts. Offered during Interim.

**Prerequisites:** CH/BIO 125 and MATH 119 or MATH 120.

### **BIO 127: Genetics and Society**

In this course, designed as an introduction to genetics and molecular biology for non-biology majors, students learn about molecular biology techniques and the use of molecular biology in medicine, forensics and agriculture. Students discuss topics such as human genetic diseases, mutations, DNA cloning, DNA fingerprinting, eugenics, gene therapy, stem cell research, and genetic privacy. Each issue is addressed on scientific and ethical levels. Offered periodically during Interim.

### **BIO 128: Water: Precious, Precarious, & Problematic**

Water is a beautifully simple molecule that is essential to survival (precious). Rivers have run dry, aquifers are overdrawn, and pollution is widespread (precarious). Much of the world lacks access to safe drinking water or water for basic sanitation, and water wars have been predicted (problematic). Students examine water from a scientific perspective - chemical, physiological, ecological - and delve into the political, economic, and societal implications of water. Offered periodically during Interim.

### **BIO 131: Field Paleontology (off campus)**

This course explores the natural history of our planet through the fossil record. Students learn from professional paleontologists and museum curators about how fossils are used in scientific research prior to embarking on a 10-day vertebrate fossil expedition in central Florida. The students then curate, catalog and interpret their data, using a large museum reference collection. Open only to sophomores, juniors, and seniors. Offered periodically during Interim. Counts toward biology major.

### **BIO 135: Thinking and Doing Biology**

Why do biologists do what they do? How is biology actually done? Students investigate the reasons biological science is done the way it is today. Students have the opportunity to design and perform their own experiments while learning the process of scientific investigation. Designed primarily for non-majors. Offered during Interim.

**BIO 143: Human Anatomy and Physiology: Cells and Tissues**

The study of the anatomy and physiology of the human body is founded on a thorough understanding of the structure and function of cells and tissues. Students attend lectures plus one 3-hour lab per week. Nursing and exercise science majors may pre-register for this course. This course may not be taken after completion of CH/BI 227 or BIO 227. Offered in the fall semester. Counts toward exercise science major.

**BIO 150: Evolutionary Foundations of Biodiversity**

This course is the gateway for the biology major, guiding students as they develop the context, skills, and modern framework on which to continue their study of biology. Students explore the history, evolution, and diversity of life in the context of genetics and comparative genomics. The laboratory emphasizes question-asking, problem-solving, and exploring biodiversity, and students have multiple opportunities to practice and communicate their science. Students attend lectures plus one 3-hour laboratory/discussion per week. Offered each semester. Counts toward biomolecular science concentration.

**BI/ES 226: Conservation Biology**

Conservation biology focuses on the study of biological diversity. Students examine why people should be concerned about the number and types of species on earth, what factors threaten the survival of species, and how people can conserve them. Using principles of ecology and evolution, with input from other disciplines, students gain a better understanding of the impact of humans on biodiversity and the importance of responsible environmental decision-making. Offered annually.

**Prerequisite:** one natural science course.

**BIO 227: Cell Biology**

This course provides a comprehensive overview of cellular structure and function including cellular compartments, macromolecular structures, and life processes such as energy and material flux, cell division, and control mechanisms. Students learn current and/or historical evidence and methodology (e.g., microscopy, isolation procedures, and probes). Laboratory experiences provide opportunities for qualitative and quantitative observations of cellular structure and function. Students place their work in the context of current research through examination of relevant literature and formal presentations. Offered each semester. Counts toward "cell biology" core category. Counts toward biomolecular science and neuroscience concentrations.

**Prerequisites:** CHEM125 or CHEM 121/CHEM 123 or CH/BI 125; BIO 150 is strongly preferred.

**CH/BI 227: Integrated Chem/Bio III: Molecular and Cellular Biology**

This course builds on the principles learned in Chemistry/Biology 125/126 and explores how chemistry informs major principles of cellular and molecular biology. Topics include cell structure, metabolism, movement, signaling, and division. The course emphasizes problem-solving, quantitative reasoning, the scientific method, and scientific writing through lectures, discussions, readings, writing assignments, and lab work. Students attend three classes and one three-hour laboratory each week. Counts toward "cell biology" core category for the Biology major. Offered annually in the spring semester.

**Prerequisite:** CH/BI 126.

**BI/ES 228: Environmental Health**

Human health is affected by the biological environment, a teeming world of parasites and diseases, and the physical environment -- the water, air, and landscapes that we inhabit. Human interactions with the environment have changed rapidly, as human populations grow, travel increases, and ecosystems are altered. This course touches upon traditional environmental topics such as air and water quality, and integrates newer public health challenges such as emerging diseases and food-borne illnesses. Counts toward management studies concentration.

**Prerequisite:** an introductory science course.

**BIO 231: Microbiology**

Microbiology examines the morphology, composition, metabolism, and genetics of micro organisms with emphasis on bacteria and viruses. Students examine the dynamic impact of microbes on humans, the immune response, and the role of microbes in the environment. Students attend lectures plus one three-hour laboratory per week. Offered annually.

**Prerequisites:** BIO 143 or BIO 150, and one Chemistry course.

**BIO 233: Intermediate Genetics**

Genetics examines relationships between genotype and phenotype in prokaryotic and eukaryotic organisms from classical and molecular perspectives. Lectures in this core course cover ideas and technologies contributing to understanding mechanisms of gene transmission and regulation. Laboratories utilize model organisms to investigate classical and molecular modes of inheritance. Students attend lectures plus one three-hour laboratory per week. Offered each semester. Counts as "genetics" core category. Counts toward mathematical biology, neuroscience, and biomolecular studies concentrations.

**Prerequisites:** BIO 150 and CHEM 125 or CHEM 121/CHEM 123 or CH/BI 125.

**BIO 242: Vertebrate Biology**

Students focus on the natural history of Upper Midwest vertebrates and phylogenetic, morphological, and functional relationships of these animals. Laboratories include identification, and morphology. During field trips, students document bird migrations, amphibian chorusing, and other animal activities. Independent projects explore topics ranging from blue bird nesting behavior to thermal conductivity and insulation in animals. Students attend lectures plus one three-hour laboratory per week. Counts as "comparative organismal biology" core category.

**Prerequisites:** BIO 150.

**BIO 243: Human Anatomy and Physiology: Organs and Organ Systems**

Students journey toward greater understanding of the human body through an integrated study of the structure of the body (anatomy) and how organs such as the brain, heart, and kidney perform their remarkable functions (physiology). The course is designed primarily for students intending careers in the health sciences. Students attend lectures plus one three-hour laboratory per week. Offered each semester. Counts toward exercise science major and neuroscience concentration.

**Prerequisite:** BIO 143, or BIO 150 and BIO 227 or CH/BI 227.



**BIO 247: Animal Physiology**

How do animals do what they need to do to survive in all sorts of environments? Why are others able to exist in only very particular conditions? These are the sorts of questions students explore as they navigate the basic systems that provide circulation, ventilation, movement, digestion, and waste removal. Students look at how these processes are coordinated by the nervous and endocrine systems and how they vary across the animal kingdom to help organisms survive in dry, hot deserts, in dark, deep oceans, and places in between. In the weekly three-hour lab, they conduct quantitative physiological measurements to assess functions such as temperature control, respiration rates, and salt and water balance. Counts as "comparative organismal biology" core category. Counts toward mathematical biology and neuroscience concentrations.

**Prerequisites:** BIO 150; BIO 227 or CH/BI 227 recommended.

**BIO 248: Invertebrate Biology**

This course traces the path of invertebrate evolution from single-celled protozoans to the most primitive chordates. Emphasis is placed upon major breakthroughs in design that enable organisms to exploit new ecological habitats. Laboratories are designed to introduce students to the major invertebrate groups via observation of living animals and through dissection. Students attend lectures plus one three-hour laboratory per week. Counts as "comparative organismal biology" core category. Counts toward neuroscience concentration.

**Prerequisites:** BIO 150.

**BIO 249: Probing Life With Light**

A range of microscopic techniques including brightfield, darkfield, interference, fluorescence, and advanced techniques including laser confocal microscopy are covered in this course. In parallel to microscope training sessions, students learn the latest computer techniques for video image grabbing and analysis. Teams design investigative projects that make use of appropriate microscope and computer technologies.

**Prerequisite:** BIO 227 or CH/BI 227. Offered during Interim.

**BIO 251: Plant Physiology**

This course begins with an in-depth look at a plant cell and its physiology, followed by a discussion of whole plant physiology as it relates to cellular functions. Students attend lectures plus one three-hour laboratory per week. Counts as "comparative organismal biology" core category.

**Prerequisites:** BIO 150, CHEM 125, and CHEM 126; BIO 227 or CH/BI 227 recommended.

**BIO 252: Plant Evolution and Systematics**

Plants are a diverse and important group of organisms. This course considers their evolution, emphasizing the morphology and anatomy of flowering plants. Students learn about basic techniques of data collection and analysis to investigate plant evolution: identifying plants, dissecting and staining plant structures, and using computer-based taxonomic statistics programs. Students attend lectures plus one three-hour laboratory per week. Counts as "comparative organismal biology" core category.

**Prerequisites:** BIO 150.

**BIO 253: Water in Morocco: Precious, Precarious, and Problematic**

Water is a beautifully simple molecule that is essential for survival (precious). Rivers have run dry, aquifers are overdrawn, pollution is widespread, and, with climate change, desert is encroaching and rains are hard to predict (precarious). In Morocco, like much of the world, safe drinking water, water for basic sanitation, or water for agriculture, is in short supply and sometimes not available at all (problematic). Students examine water from a scientific perspective -- chemical, physiological, ecological -- and delve into the historical, political, economic, and social implications in Morocco -- a country of diverse cultures and biotic zones from two oceans, mountain ranges, and the driest of dry deserts. Students learn through readings, lectures, student presentations, and field trips. This class is suitable for any student with sophomore standing. First-year students having completed Bio 150, or ES 137 may be considered. Counts toward biology major, environmental studies major (natural science elective), and Middle Eastern studies concentration.

**BIO 261: Ecological Principles**

Ecology focuses on the study of the interrelationships that determine the distribution and abundance of organisms. This core course examines organism-environment interactions and the study of populations, communities and ecosystems. Consideration is given to use of ecological studies in ecosystem management. Students attend lectures plus one three-hour laboratory per week. Offered each semester. Counts as "ecology" core category. Counts toward environmental studies major (all emphases) and concentration and mathematical biology concentration.

**Prerequisites:** BIO 150.

**BIO 266: Comparative Vertebrate Anatomy**

What happened to the dinosaurs? Can some human congenital heart defects be explained by reference to cardiovascular systems of diving turtles? Examining the origin and evolution of vertebrates, comparing morphology across vertebrate taxa and examining selective factors leading to modern forms is of value to health science students, graduate studies in biology, and people who like dinosaurs. Students attend lectures plus one three-hour laboratory per week. Counts as "comparative organismal biology" core category.

**Prerequisites:** BIO 150.

**BIO 275: Biology of Reproduction**

The ability to reproduce is one of the key features of a living organism. Studying the biology of reproduction requires a synthesis of information and concepts from a wide range of fields within biology. This course addresses reproduction at the genetic, organismal, and population levels. Laboratory work adds a valuable investigative component to the course, and social/psychological issues are addressed throughout. Counts as "comparative organismal biology" core category. Counts toward women's and gender studies major and concentration if approved by petition.

**Prerequisites:** BIO 150 or permission of instructor.

**BIO 284: Peruvian Medical Experience (abroad)**

This course is a service/learning experience. Week one is spent on campus learning basic clinical techniques, examining emerging disease, and studying existing health care issues. Students spend three weeks in Cuzco, Peru, assessing patient needs in a public hospital, a homeless shelter, orphanages, and a small village. Week four involves discussion and writing reflective journals. Apply through the Office of International and Off-Campus Studies. Offered during Interim.

**Prerequisites:** BIO 150 or BIO 231, and BIO 291.

**BI/ES 286: Tropical Ecology and Sustainable Land Use in Costa Rica (abroad)**

This course offers students the opportunity to study first-hand the most diverse ecosystems on earth. In this intensive field-oriented course students explore lowland rainforest, montane forest, dry forest, and coastal and agricultural ecosystems through projects and field trips. Students read and discuss texts and primary literature specific to ecology, evolution, conservation, and agricultural practices of each area, and keep reflective journals. Offered during Interim in alternate years.

**Prerequisite:** one science course.

**BIO 287: Island Biology in the Bahamas (abroad)**

Intensive study of the biology that created the Bahamas and that now constitutes the living structure of these islands. Staying at the Gerace Research Center provides access to a diversity of marine and terrestrial habitats including coral reefs, seagrass beds, mangrove forests, hypersaline ponds, limestone caverns, and the "blue-holes" that connect inland waterways to the sea. The Gerace Research Center is located on San Salvador Island. Offered during Interim. Counts toward Biology major.

**Prerequisite:** BIO 150 or permission of instructor.

**BIO 288: Equatorial Biology (abroad)**

This course offers intensive field-biology experiences within three equatorial New World environments: the Amazon rainforest, the Andes cloud forests, and the Galapagos Islands. Students compare the rich biodiversity, the adaptations and natural history of species, and the influence of human impact on these areas. Preparation for class requires readings from texts and primary literature concerning ecological and environmental issues specific to each of these regions. Based in Quito, the three field expeditions alternate with home-based rest days allowing for reflective writing in journals, assimilation, and discussion. Offered during Interim.

**Prerequisite:** BIO 150 or permission of instructor.

**BIO 291: Topics in Biological Research (0.25)**

For science majors, learning to read the primary literature and other professional sources is an important transition from classroom learning to post-graduate endeavors. Students read, present, and discuss scientific literature in a field selected by participating faculty. The goal is to garner sufficient expertise to allow critical analysis of the particular field. Requires permission of instructor. May be repeated if topic is different.

**BIO 292: Topics in Biology**

Students study topics in biology. Topics vary from year to year at the discretion of the department. Class work depends on the topics and instructor, but is consistent with the amount and level of work in other 200-level biology courses. May be repeated if topics are different. Prerequisites vary. Counts as an elective toward biology major. May count toward other majors or concentrations if approved by the chair of that major/concentration. Offered periodically.

**BIO 294: Academic Internship**

Internships are designed to provide career-testing opportunities. Students interested in an internship should consult with the Piper Center for Vocation and Career, enlist a faculty supervisor, and complete an internship application. Internships do not count toward the biology major requirements.

**BIO 298: Independent Study**

Independent study allows students to study in an area not covered in the regular biology course offerings. The student undertakes substantial independent study in a defined biological field, meets regularly with faculty supervisor, and prepares some form of presentation of the material learned. The student must obtain permission of supervisor and complete an independent study form available from the Registrar's Office or its Web site.

**BIO 315: Principles of Bioinformatics**

Students apply computational techniques and tools to the analysis of biological data. From mining large genetic sequence databases to simulating population dynamics, computer programming is rapidly becoming essential to the study of a broad range of biological systems. This course introduces computer programming to biologists and allows for the creative application of this skill to an array of biological questions, with an emphasis on advanced genetics topics. Counts toward biomolecular science and mathematical biology concentrations.

**Prerequisite:** BIO 233.

**BIO 341: Advanced Cell Biology**

The cell is the fundamental unit of life, capable of growth, motility, signal transduction, and functional specialization. Students study features common to cells: their macromolecular components, metabolism, membrane transport, motility, signal mechanisms, and intracellular trafficking, seeing how these are elaborated in cells with particular specializations. Research techniques suitable for cell biology are emphasized. Students attend lectures plus one three-hour laboratory per week. Counts toward neuroscience and biomolecular science concentrations.

**Prerequisites:** BIO 227 and BIO 233, or CH/BI 227 and BIO 233, or permission of instructor.

**BIO 348: Research in Electron Microscopy (off campus)**

This course introduces students to intensive research at St. Olaf and the Boulder Laboratory for 3-D Electron Microscopy of Cells at the University of Colorado. In Boulder, students prepare samples for electron microscopy and immuno-gold Electron Microscopy, capture EM-images, and generate 3-D Tomograms. At St. Olaf students generate 3-D computer models of their datasets. Offered periodically during Interim.

**Prerequisite:** three courses in biology or permission of instructor.

**BI/ES 350: Biogeochemistry: Theory and Application**

The study of global change and human environmental impacts requires students to link concepts from biology, chemistry, and physics. Students investigate these links by exploring current theories in biogeochemistry, with an emphasis on understanding the feedback between physical and ecological processes and the coupling of multiple element cycles. Laboratory activities focus on a practical exploration of the methods biogeochemists use, including experience with a variety of instruments. Counts toward mathematical biology concentration.

**Prerequisite:** any level II biology, chemistry, or physics course or permission of instructor.

**BIO 363: Limnology**

Limnology is the study of inland waters and includes their physical, chemical, and biological characteristics. The course focuses on biotic processes and interactions set within the abiotic habitat of lakes and streams. Students examine current management problems facing freshwater environments by focusing on human-induced changes to aquatic habitats and their biotic consequences. Investigative laboratories introduce students to aquatic habitats and biological processes within them.

**Prerequisites:** BIO 261, or permission of instructor.

**BIO 364: Molecular Biology**

Molecular biology techniques are bringing about a revolution in understanding living organisms. Students study the structure and function of macromolecules, methods currently used to clone and analyze genes, and new insights into basic biological processes which these methods provide. The course uses lecture and discussion topics with one project-oriented three-hour laboratory per week. Counts toward biomolecular science and neuroscience concentrations.

**Prerequisite:** BIO 233.

**BIO 371: Field Ecology**

This course focuses on learning modern field and laboratory methods to test ecological hypotheses. Students work on group and individual projects to collect and analyze data and give oral and written presentations on projects. Class periods focus on discussion of primary literature and project results. Class trips include visits to local natural areas. Students attend lecture/discussion plus one four-hour laboratory per week. Counts toward environmental studies major (natural science emphasis) and mathematical biology concentration.

**Prerequisite:** BIO 261.

**BIO 372: Developmental Biology**

The last decade has unveiled the mechanism by which a single cell gives rise to an embryo rich in pattern and cellular diversity. This course traces the use of surgical, genetic, and molecular techniques as they have uncovered the developmental blueprints encoding the universal body plan fundamental to all metazoan life. Students attend lectures plus one three-hour laboratory per week. Counts toward neuroscience and biomolecular science concentrations.

**Prerequisite:** BIO 233.

**BIO 375: Advanced Supplemental Research (0.25)**

Students work on special projects during one afternoon of laboratory per week. Each student must have the sponsorship of a faculty member. This course does not count toward the biology major. P/N only. Offered each semester. May be repeated if topic is different.

**BIO 382: Immunology**

Immunology focuses on the structure, development and function of the immune system. The course explores the molecular and cellular basis of the immune responses. The application of immunological principles to allergy, autoimmunity, AIDS, transplantation, and cancer are included. Students attend lectures plus a two-hour discussion per week. Counts toward biomolecular science concentration.

**Prerequisite:** BIO 227 and BIO 233, or CH/BI 227 and BIO 233.

**BIO 383: Evolutionary Biology**

The idea of evolution forms the foundation for all modern biological thought. This course examines the processes of evolution in detail (selection, genetic drift, mutation, migration) and studies the methods by which biologists reconstruct the history of life on the planet. Advanced topics are explored through reading and discussion of journal articles. The social and historical context of evolutionary theory is discussed. Counts toward biomolecular science and mathematical biology concentrations.

**Prerequisite:** BIO 233.

**BIO 385: The Neuron**

From tiny ion channels to the basis for learning, neuroscience is a rapidly developing area. Using texts, reviews, and current literature, students examine in depth the fundamental unit of the nervous system, the neuron. The goals are to understand how neurons accomplish their unique functions: electrical signaling, synaptic transmission, and directed growth and remodeling. Counts toward neuroscience concentration.

**Prerequisites:** BIO 227 or CH/BI 227 and progress toward a major in any of the natural sciences.

**BIO 386: Animal Behavior**

This course approaches the study of animal behavior from the blended viewpoints of evolutionary behavioral ecology and comparative psychology. Mechanisms of learning, cognition and development, as well as aggression, territoriality, and mating are examined at the organismic and cellular level. A deeper understanding of the neural and environmental determinants of behavior in a wide variety of species helps students better understand themselves and their place in nature. Laboratory work reinforces class material. Counts toward neuroscience concentration.

**Prerequisite:** progress toward a major in any of the natural sciences.

**BIO 391: Selected Topics**

Specific topics announced prior to each term are based on student interests and available staff. Class work includes comprehensive review of literature on the specific topic. Class meetings present topics in discussion format. May be repeated if topic is different. Counts toward environmental studies major (all emphases) and concentration when taught with environmental science focus and approved by chair.

**Prerequisites:** vary.

**BIO 394: Academic Internship**

Biology 394 is for students who have completed one internship (BIO 294) and wish to complete a second internship. Students interested in an internship should consult with the Piper Center for Vocation and Career, locate a faculty supervisor, and complete an internship form. Internships do not count toward the biology major requirements.

**BIO 396: Directed Undergraduate Research**

This course provides a comprehensive research opportunity, including an introduction to relevant background material, technical instruction, identification of a meaningful project, and data collection. The topic is determined by the faculty member in charge of the course and may relate to his/her research interests. Offered based on department decision. May be offered as a 1.00 credit course or .50 credit course.

**Prerequisite:** determined by individual instructor.

**BIO 398: Independent Research**

Independent research is offered for students dedicated to an in-depth research experience. In conjunction with a faculty supervisor, a student conceives and performs a research project leading to the production of a major piece of work such as a research paper or poster presentation. Independent research requires permission of a supervisor and completion of an independent research form available at the Registrar's Office or its Web site.

## Faculty

**Chair, 2016-2017****Kimberly A. Kandl**

Associate Professor of Biology  
cell biology; molecular biology; genetics

**Sarah Amugongo**

Assistant Professor of Biology  
physiology; evolutionary biology

**Diane K. Angell**

Assistant Professor of Biology  
conservation biology; ecology; evolutionary biology

**Lisa M. Bowers** (on leave fall)

Assistant Professor of Biology  
microbiology; genetics; molecular biology; synthetic biology

**Eric Cole**

Professor of Biology  
developmental biology; invertebrate zoology

**Kevin M. Crisp**

Associate Professor of Biology  
electrophysiology; computational neuroscience; medical devices

**James A. Demas**

Assistant Professor of Biology and Physics  
neuronal biophysics; sensory circuits; retinal neurophysiology

**Steven A. Freedberg**

Associate Professor of Biology  
evolutionary biology; computer simulation modeling; bioinformatics

**Sara E. Fruehling**

Visiting Assistant Professor of Biology  
microbiology; virology; genetics

**John L. Giannini** (on leave Interim)

Associate Professor of Biology  
cell biology; membrane transport associated with plants and fungi

**Laura L. Listenberger**

Associate Professor of Biology and Chemistry  
lipid biochemistry; cell and molecular biology

**Emily K. Mohl**

Assistant Professor of Biology and Education  
evolutionary ecology; plant-insect interactions; science education

**Beth Pettitt** (on leave fall)

Visiting Assistant Professor of Biology  
behavioral ecology; animal communication; wildlife field research

**Jean C. Porterfield**

Associate Professor of Biology

evolutionary biology; molecular ecology; gene expression analysis

**Kevin B. Potts**

Visiting Assistant Professor of Biology  
animal behavior; comparative vertebrate anatomy and physiology;  
human evolution

**Rachel Putnam**

Visiting Assistant Professor of Biology  
ecology; plant biology

**Kathleen L. Shea**

Professor of Biology and Environmental Studies, Curator of Natural Lands  
plant ecology and evolution; restoration ecology; agroecology

**Nicole J. Son**

Visiting Assistant Professor of Biology  
neurobiology; human biology; cell biology; microscopy

**Charles E. Umbanhowar**

Professor of Biology and Environmental Studies  
prairie ecology; botany; paleoecology; fire ecology; biogeochemistry

**Anne Walter** (on leave)

Professor of Biology  
comparative animal and cell physiology; membrane physiology and biophysics; comparative enzymology; applying biology in international settings