

# BIOLOGY

The field of Biology represents a number of different approaches to the study of life, from the molecular to organismal to ecological levels.

## ABOUT THE PROGRAM

The Department of Biology offers all Hope College students an opportunity to participate in biology, either in courses listed here or in some of the GEMS and Environmental Science courses. Several members of the Department of Biology faculty have been recognized as outstanding educators at the state and national levels. Biology majors leave Hope College well prepared to pursue a number of different careers. Many of our majors go on to earn advanced degrees in graduate, medical, dental or other professional schools. Our success at placing students in graduate and professional schools is outstanding. Other students go on to careers in the allied health professions, industrial research and laboratory positions, conservation and natural resources management, secondary education and environmental/outdoor education.

We give students the chance to learn biology in well-taught courses in a diverse curriculum. Courses emphasize active participation by the students in lecture, discussion and laboratory settings. A hallmark of the department's approach is the belief that students best learn biology by doing biology. Thus, almost all of our courses include investigative laboratories. In addition, we provide students with the opportunity to be biologists by participating in research projects with our faculty. Student/faculty research occurs both in the summer, when stipends are available to give selected students the experience of full-time research, and during the academic year. More than 100 research papers co-authored by students have been presented or published in the last five years. The variety of research projects reflects the diversity of interests of the biology faculty:

- Ecologists are studying seed banks and tropical forest regeneration, effects of endophytic fungi on insects, behavioral ecology of birds and the ecology of invasive plants
- Botanists are investigating molecular plant systematics
- Physiologists are studying impacts of heat exposure in rats, the role of vasopressin receptors, the regulation of body mass and reproduction in vertebrates and the electrophysiology of the hippocampus
- Geneticists, cell biologists and molecular biologists are studying receptor function and molecular biology of lipid metabolism
- Zoologists are investigating interactions between insects, fungi, and grasses; and competition for nesting sites among bird species

The department has many well-equipped laboratories and a 55-acre nature preserve for both teaching and research and a well-supplied library of books and current journals. More recent additions to our capabilities include a computer laboratory for bioinformatics studies,

statistical analyses and simulation studies, an apotome/fluorescence microscope, diode array spectrophotometers, an automated next generation DNA sequencer, a real-time PCR thermal cycler, scintillation counters, a video image analysis system, a confocal microscope, a portable photosynthesis system, equipment for electrophysiological studies, seven computerized polygraphs for physiological measurements, five walk-in and numerous reach-in environmental chambers, new field equipment, two molecular biology laboratories and facilities for plant and animal tissue culture and gene cloning and amplification.

Qualified students can spend a semester at a university abroad or in an internship while pursuing their other studies at Hope College or during participation in one of the college's domestic off-campus programs.

A Bachelor of Science degree in Biochemistry and Molecular Biology is offered jointly by the departments of Biology and Chemistry and is available for those students who seek a degree at the interface of these two disciplines. You may find complete description of the requirements for this degree [here](#).

## MAJORS

A Hope College biology major must be prepared to meet a variety of future challenges . For that reason, the basic requirements are distributed among the diversity of approaches to the study of biology. Students should discuss their individual needs with a member of the Department of Biology as early as possible so that those needs can be met.

### Biology

The General Biology classes (BIO 105 and 106) and laboratory (BIO 107 and 108 or 207 and 208) are referred to as the "core courses in biology" throughout the catalog.

#### Basic major requirements:

The B.A. in biology requires completion of at least 28 credits of biology, including:

- The two required core biology courses
- 1 semester of a 4-credit mathematics course
- 1 year of chemistry (major level courses are strongly recommended).

The B.S. in biology requires 36 credits in biology, including:

- The two required biology core courses
- CHEM 314 and 315 (may be counted as biology credits for the B.S. degree)
- CHEM 125, 127, 128, 126 (or 131, 132), 221, 231 and 255

2 semesters of 4-credit courses in mathematics, or one semester of a 4- credit mathematics course  
And CSCI 160 - Scientific Computer Programming

- 8 additional credits from courses in the natural science departments other than biology and chemistry

Students must have a minimum GPA of 2.0 in biology to graduate with a major.

#### Required courses:

Biology majors desiring either a B.A. or B.S. must take the entry-level core courses in biology. The two General Biology courses provide a comprehensive overview of the basic principles of biology. They stress the central ideas in the biological sciences, such as ecology and evolution, adaptation, structure-function relationships and the global diversity and unity of life with an emphasis on the process of scientific discovery and investigation.

To ensure students are exposed to advanced study in the major areas of biology, at least one course in each of the following areas must be taken:

- BIOL 221, 301\*, 332\*, 340, 370, 374\*, 422\*,432\*,442 – Organismal Biology
- BIOL 295, 335, 356/357, 348/349, 355, 366, 395 – Cell/Molecular Biology (Bioinformatics)
- BIOL 315, 343\*, 380\*, 421, 330\* – Ecology & Evolutionary Biology
- BIOL 318, 490,495 – Professional Development (Capstone, Journal Club)

In addition, to ensure students are informed about the important topic of biological diversity, at least one of the courses above with an asterisk is required.

#### Important Considerations:

1. Core courses in biology (105, 106 and either 107 and 108 or 207 and 208) and CHEM 125, 127, 128 and 126 (or 131 and 132) should be taken in the first year of college, if possible.
2. Students planning to attend graduate, medical or dental schools or pursue other biology careers that require rigorous training, should take mathematics; one year of physics; and CHEM 125, 127, 128 and 126 (or 131 and 132), 221, 231, 255 and biochemistry, statistics and computer programming are desirable for many biological careers.

### Biology Education

In partnership with the Hope College Department of Education, the Department of Biology offers a teaching major and minor for certification through the State of Michigan (see the [Department of Education](#) website.)

Majors desiring a B.A. must take a minimum of 30 credits in biology, beginning with the two-course core.

Biology secondary teacher candidates must choose an additional 22 credits.

In addition to biology course work, teacher candidates must take one semester of a 4-credit mathematics course and a year of chemistry.

## MINORS

### Biology

The minimum requirement for a biology minor is 20 credits of biology, including core courses in biology, plus 12 more credits selected from other courses in the department. Students must have a minimum GPA of 2.0 in biology to graduate with the minor.

If earning a minor for secondary teacher certification, students must have at least a 2.5 GPA.

### Biology Education

In partnership with the Hope College Department of Education, the Department of Biology offers a teaching major and minor for certification through the State of Michigan (see the [Department of Education](#) website.)

Minors for secondary teacher certification must take a minimum of 20 credits in biology, beginning with BIOL 105, 106, 107 and 108. An additional 12 credits may be chosen from the same biology department electives as the secondary teacher certification major.

Because of the expectations for high school teaching, BIOL 221, Human Physiology, is strongly recommended for teacher education candidates.

Courses designed for students preparing for careers in the allied health fields. These courses do not count toward a biology major or minor.

## COURSES

### BIOLOGY

#### **BIOL 103 - Introduction to Cell Biology**

A study of the fundamentals of cell biology and genetics. Three lectures and one 3-hour laboratory period per week. Not open to students who have taken Biol 240 or Biol 105 and 106.

**Credits Awarded:** 4

**Terms Offered:** Fall

**Attribute:** Natural Science I with lab (NSL)

#### **BIOL 104 - Organisms and Environments**

This is the second of a two-semester sequence of courses. The combined courses ("Matter and Energy" and "Organisms and Environments") will satisfy the natural science laboratory general education requirements only for elementary education teacher candidates. The courses will also cover the content that is important for future educators in an integrated inquiry-based format. The content in this recommended course sequence will flow from the physical science to earth/space science to life science topics that students will find themselves teaching in the future. This course will primarily include content from the life and earth/space science, though due to the interdisciplinary nature of many of the topics, physical science topics will also be addressed where appropriate.

**Credits Awarded:** 4

**Terms Offered:** Fall, Spring

**Attribute:** Natural Science I with lab (NSL)

#### **BIOL 105 - General Biology I**

This course includes an overview of ecology emphasizing the ways organisms interact with their physical and biological environment, and the study of animal and plant diversity, anatomy and physiology with an emphasis on structure-function relationships and homeostasis. Three lectures per week.

**Credits Awarded:** 3

**Terms Offered:** Fall

**Corequisites:** Biol 107

**Attribute:** Natural Science I with lab (NSL)

#### **BIOL 106 - General Biology II**

This course includes the study of cell biology, including cellular structure and function, metabolism, enzyme activity, and energetics, Mendelian and molecular genetics, including discussion and use of modern techniques as a means to answer biological questions, and evolutionary biology, including the relationships between the major taxa, and how the interaction of organisms with their environment drives the evolutionary process. Three lectures per week.

**Credits Awarded:** 3

**Terms Offered:** Spring

**Prerequisites:** Biol 105

**Corequisites:** Biol 108

**Attribute:** Natural Science I with lab (NSL)

**BIOL 107 - General Biology Laboratory I**

Laboratory experiences designed to complement lecture material in Biol 105. The labs are organized into research experience modules. In this semester, students investigate questions in ecology, animal and plant biology.

Credit Awarded: 1  
 Terms Offered: Fall  
 Corequisites: Biol 105  
 Attribute: Natural Science I with lab (NSL)

**BIOL 108 - General Biology Laboratory I**

Laboratory experiences designed to complement lecture material in Biol 106. The labs are organized into research experience modules. In this semester, students investigate questions in cell biology, molecular genetics and evolution.

Credit Awarded: 1  
 Terms Offered: Spring  
 Prerequisites: Biol 105  
 Corequisites: Biol 106  
 Attribute: Natural Science I with lab (NSL)

**BIOL 195 - Studies in Biology**

A course offered in response to student and instructor interest. Topics are not generally covered in the regular course listings. Course may be taken multiple times if topics are different.

Credits Awarded: 0-4  
 Terms Offered: As Needed  
 Prerequisites: Permission of instructor

**BIOL 207 - Honors Laboratory in Cells and Genetics**

This research based laboratory course is the first part of a two-semester introductory biology laboratory sequence. The full-year course covers basic techniques in microbiology, molecular biology, genetics, evolutionary biology and computer based bioinformatics analysis of viral genomes through the exploration of Mycobacteriophage diversity. In this first semester, students will focus on various wet laboratory skills in microbiology, molecular biology and genetics. Enrollment is by invited application only. One 3-hour laboratory session and one 2-hour laboratory session per week.

Credits Awarded: 2  
 Terms Offered: Fall  
 Prerequisites: Permission of instructor  
 Corequisites: Biol 105  
 Attribute: Natural Science I with lab (NSL)

**BIOL 208 - Honors Laboratory in Cells and Genetics**

This research based laboratory course is the second part of a two-semester introductory biology laboratory sequence. The full-year course covers basic techniques in microbiology, molecular biology, genetics, evolutionary biology and computer based bioinformatics analysis of viral genomes through the exploration of Mycobacteriophage diversity. In this second semester, students will focus on various topics in bioinformatics, comparative genomics, and evolutionary biology. Two 2-hour computer laboratory session per week.

Credits Awarded: 2  
 Terms Offered: Spring  
 Prerequisites: Biol 207, Permission of instructor  
 Corequisites: Biol 106  
 Attribute: Natural Science I with lab (NSL)

**BIOL 221 - Human Physiology**

A study of the function and interactions of the various organ systems of the human body. Three lectures and one 3-hour laboratory period per week. Prior completion of Biol 103 or Biol 106 and 108 or the equivalent is highly recommended prior to this course.

Credits Awarded: 4

Terms Offered: Fall, Spring

Attribute: Natural Science I with lab (NSL)

**BIOL 222 - Human Anatomy**

A course where the human body is studied from histological and gross anatomical perspectives. Laboratories require dissections, microscope work, and use of computer programs. Three lectures and one 3-hour laboratory period per week. Cross-listed with Kin 200.

Credits Awarded: 4

Terms Offered: Fall, Spring

Attribute: Natural Science I with lab (NSL)

**BIOL 231 - Microbiology for the Allied Health Professions**

A study of selected bacteria, viruses and parasites with an emphasis on host-microbe interactions and microorganisms implicated in human disease. Three 1-hour lectures and two 2-hour laboratories per week. Not open to students who have had an advanced microbiology course. Students may take Chem 103 either prior to enrollment in or concurrently with the class.

Credits Awarded: 4

Terms Offered: Spring

Prerequisites: Biol 103, Chem 103

Corequisites: Chem 103

**BIOL 295 - Studies in Biology**

A course offered in response to student and instructor interest. Topics are not generally covered in the regular course listings. Course may be taken multiple times if topics are different.

Credits Awarded: 0-4

Terms Offered: As Needed

**BIOL 301 - General Microbiology**

An introduction to the field of microbiology covering physiological and molecular characteristics of microorganisms (bacteria, archaea, viruses and microbial eukaryotes) in the context of evolution and diversity. Special emphasis will be given to pathogenicity and interactions of microbes with the human immune system. Three lectures and two 2-hour laboratories per week. Additional out-of-class hours are required.

Credits Awarded: 4

Terms Offered: Fall

Prerequisites: Biol 105 and Biol 106

Attribute: Natural Science I with lab (NSL)

**BIOL 315 - Advanced Topics in Ecology**

A course that deals with the interactions between organisms and their physical and biological environments at an advanced level, emphasizing recent developments and specialized problems. Areas of emphasis (e.g., conservation biology, plant-animal interactions, community ecology, and physiological ecology) as well as course format (lecture-lab, lab only) and credits (1-4) will vary.

Credits Awarded: 1-4

Terms Offered: Fall, Spring

Prerequisites: Biol 105 and Biol 106

**BIOL 318 - Mathematical Biology**

An exploration of the ways in which mathematics is used to understand and model biological systems. Using examples from ecology, neuroscience, epidemiology, and molecular evolution, we will focus on continuous and discrete models and their analytical and computational solutions. Systems of differential equations, linear algebra, and statistical methods will figure prominently among the mathematical topics. Students will become familiar with the statistical, graphical & modeling capabilities of the R computer language. Cross-listed with Math 318.

Credits Awarded: 4

Terms Offered: Spring, Odd Years

**BIOL 320 - Plant Physiology**

A study of the physical processes, nutrition, metabolism, biochemistry, and growth and development of plants and how these functions are affected by changes in the environment and in responses to other organisms. These plant functions will be examined at the molecular, cellular and organismal levels. Three lectures and one 3-hour laboratory per week. Students may take Chem 221 either prior to enrollment or concurrently with the class.

Credits Awarded: 4

Terms Offered: Fall, Odd Years

Prerequisites: Biol 105 and Biol 106, Chem 221

Corequisites: Chem 221

**BIOL 330 - Marine Biology and Biophysics**

An interdisciplinary course focusing on the biology of marine organisms and the physicochemical and geological factors that govern their distribution, abundance, and characteristics. The course covers much of the subject matter of a traditional marine biology course, including a survey of important groups of marine organisms and ecosystems, but it also delves frequently into the ways in which physics informs a deeper understanding of the special challenges of life in the sea and adaptations of organisms to deal with those challenges. Three lectures and one 3-hour laboratory per week. Instruction in SCUBA and a field trip to Caribbean coral reef habitats during spring break will be available to students as an option, at extra cost. Cross-listed with Phys 330.

Credits Awarded: 4

Terms Offered: Spring, Odd Years

**BIOL 332 - Comparative Anatomy of Vertebrates**

An evolutionary study of vertebrate bodies, emphasizing structural adaptations to functional problems imposed by different environments. Laboratory work includes extensive dissections of a variety of aquatic and terrestrial vertebrates.

Credits Awarded: 4

Terms Offered: Spring, Odd Years

Prerequisites: Biol 105 and Biol 106

Attribute: Natural Science I with lab (NSL)



**BIOL 335 - Neurochemistry and Disease**

In this course, students will explore how the biochemistry of the brain influences nervous system function, specifically in relationship to motor and cognitive processes. Students will initially be introduced to fundamental aspects of neuroscience and biochemistry in a traditional lecture format. After this introduction, students will explore the relationship between altered neurochemical activity and disease states using a case study approach. In the lab, students will be introduced to several neurochemistry techniques and will then be asked to use these tools to complete a novel neurochemistry research project. Neurochemistry and Disease meets three times a week for one hour. In addition, students are required to complete one, 3-hour laboratory each week. Cross-listed with Chem 335.

**Credits Awarded:** 4

**Terms Offered:** Spring, Even Years

**Prerequisites:** Biol 105 and Biol 106, Or Chem 311 or Nsci 211

**Attribute:** Natural Science I with lab (NSL)

**BIOL 340 - Advanced Topics in Plant Biology**

An in-depth study of specialized topics in botany such as plant anatomy, plant breeding systems, plant molecular systematics, and ecophysiology of plants. Three ethnobiology lectures and one 3-hour laboratory per week.

**Credits Awarded:** 4

**Terms Offered:** Fall, Even Years

**Prerequisites:** Biol 105 and Biol 106

**BIOL 343 - Vascular Plant Systematics**

A study of the biology, evolutionary relationships and identification of selected families of vascular plants, and the principles of plant classification. The laboratory will involve field work and concentrate on the local flora. Two 3-hour lecture and laboratory session per week. Additional out-of-class hours are required.

**Credits Awarded:** 4

**Terms Offered:** Fall, Odd Years

**Prerequisites:** Biol 105 and Biol 106

**BIOL 348 - Advanced Cell Biology**

An advanced study of cell structure, function and regulation of eukaryotic cells. The goal of this course is for students to learn and understand cellular/molecular mechanisms that are essential in the maintenance of cellular homeostasis. The specific topics include cell membrane, cell organelles, cytoskeleton, extracellular matrix and cell cycle. The gene structure and function is also explored. Three lectures per week.

**Credits Awarded:** 3

**Terms Offered:** Spring

**Prerequisites:** Biol 105 and Biol 106

**BIOL 349 - Advanced Cell Biology Laboratory**

The laboratory course employs an investigative project approach and introduces students to the scientific literature, “research proposal” writing, and latest technologies used to investigate cellular function. The experiments focus on the cancer cell as a model and employ such techniques as cell culture, assays measuring cell proliferation and apoptosis, RNA isolation and microarray analysis, immunocytochemistry, and finally, protein analysis through gel electrophoresis and Western blotting. One 3-hour laboratory per week. Students may take Biol 348 either prior to enrollment in or concurrently with the class.

**Credit Awarded:** 1  
**Terms Offered:** Spring  
**Prerequisites:** Biol 348  
**Corequisites:** Biol 348

**BIOL 355 - Developmental Biology**

A study of the processes involved in the development of animal embryos, including regeneration and metamorphosis. The course integrates the descriptive, comparative and molecular approaches to the study of development. Three lectures and one 3-hour laboratory per week.

**Credits Awarded:** 4  
**Terms Offered:** Spring  
**Prerequisites:** Biol 105 and Biol 106

**BIOL 356 - Genetics**

A comprehensive overview of genetics from its classical beginnings, including Mendelian genetics, linkage, chromosomal aberrations and extranuclear inheritance to modern molecular genetics. After a thorough grounding, topical subjects are covered in the last part of the semester, and have included cancer genetics, genetics of behavior, and population genetics. Three lectures a week. The laboratory (1 credit) is optional, and may be taken concurrently with the course.

**Credits Awarded:** 3  
**Terms Offered:** Fall, Spring  
**Prerequisites:** Biol 105 and Biol 106

**BIOL 357 - Genetics Laboratory**

Designed to introduce the student to the experimental basis of lecture topics. Investigations include the purification and analysis of DNA, generation and sequencing of recombinant DNA molecules, and *Drosophila* and bacterial genetics. Students may take Biol 356 either prior to enrollment in or concurrently with the class.

**Credit Awarded:** 1  
**Terms Offered:** Fall, Spring  
**Prerequisites:** Biol 356  
**Corequisites:** Biol 356

**BIOL 366 - Molecular Biology**

An advanced course which examines the role of gene structure, function, and regulation at the molecular level to explain biological processes. Topics include basic processes such as DNA replication, recombination, and regulation of gene expression, as well as an emphasis on experimental design and techniques. The laboratory component of the course uses a project approach to introduce experimental design and molecular biological methods as students clone and characterize a gene. Three lectures and one 3-hour laboratory per week. Biol 356 is highly recommended prior to this course.

Credits Awarded: 4  
 Terms Offered: Fall  
 Prerequisites: Biol 105 and Biol 106, Chem 231

**BIOL 370 - Animal Behavior**

An investigation-based study of vertebrate and invertebrate behavior from an evolutionary perspective. Topics include proximate behavioral mechanisms (genetic, developmental and neurological) and ultimate consequences (evolution, ecology and sociology). Two 3-hour laboratories per week plus additional required out-of-class hours. Statistics is highly recommended prior to this course.

Credits Awarded: 4  
 Terms Offered: Fall, Odd Years  
 Prerequisites: Biol 105 and Biol 106

**BIOL 374 - Biology of Insects**

The course is an introduction to the identification, structure, life cycle and behavior of insects. Field aspects will be stressed. Two 3-hour lecture/laboratory periods per week, plus additional required out-of-class hours.

Credits Awarded: 4  
 Terms Offered: Fall  
 Prerequisites: Biol 105 and Biol 106

**BIOL 380 - Field Studies in Biology**

A concentrated study of a variety of organisms in their natural habitats. Normally requires field studies or camping trips as long as two to three weeks in duration. In addition study projects and/or papers will be expected. May be repeated for a maximum of 8 credits.

Credits Awarded: 1-4  
 Terms Offered: Summer  
 Prerequisites: Biol 105 and Biol 106

**BIOL 390 - Independent Study of Biology**

A special course to allow students to study an area of biology not included in the regular curriculum or an in-depth study of a selected biological topic.

Credits Awarded: 1-3  
 Terms Offered: Fall, Spring  
 Prerequisites: Biol 105 and Biol 106, Permission of instructor

**BIOL 395 - Studies in Biology**

This course may be a lecture or laboratory on a topic in biology related to special interests of the faculty or to significant current developments in the field.

Credits Awarded: 1-4  
 Terms Offered: As Needed  
 Prerequisites: Biol 105 and Biol 106

**BIOL 421 - Evolutionary Biology**

A study of special topics concerning the process of evolution and its mechanisms involving both micro and macro evolution. Each year a different special topic is explored. Past examples include evolutionary molecular biology and speciation. Three lectures and one laboratory/discussion per week.

Credits Awarded: 4  
 Terms Offered: Spring  
 Prerequisites: Biol 105 and 106

**BIOL 422 - Invertebrate Zoology**

The biology of selected invertebrate animals will be studied with emphasis on their functional morphology, ecology and behavior. Laboratory includes field studies with a weekend trip to southern Indiana. Two 3-hour laboratory/lecture sessions per week, plus additional out-of-class hours.

**Credits Awarded:** 4  
**Terms Offered:** Fall, Even Years  
**Prerequisites:** Biol 105 and 106

**BIOL 432 - Vertebrate Zoology**

Vertebrate examples are used to investigate a broad range of biological topics including evolution, speciation, historical and modern zoogeography, energetics, behavior, ecology and conservation. Laboratory includes both laboratory exercises and field trips that focus on the taxonomy, external morphology, natural history and field identification of local vertebrates. Three lectures and one 3-hour laboratory per week. Additional out-of-class hours are required.

**Credits Awarded:** 4  
**Terms Offered:** Spring, Odd Years  
**Prerequisites:** Biol 105 and 106

**BIOL 442 - Advanced Topics in Animal Physiology**

An in-depth examination of comparative aspects of animal physiology such as cardiovascular systems, renal physiology, endocrinology, immunology, or environmental physiology. Three lectures and one 3-hour laboratory per week, or two lectures and two 2-hour laboratories per week. Additional out-of-class hours are required. Biol 221 is highly recommended prior to this course.

**Credits Awarded:** 4  
**Terms Offered:** Spring, Odd Years  
**Prerequisites:** Biol 105 and 106

**BIOL 490 - Research in Biology**

This course is designed to give students majoring in biology a chance to do research in an area in which they have a special interest. Students are expected to attend weekly seminars. Requires formal application and permission of the instructor with whom the student will work.

**Credits Awarded:** 0-3  
**Terms Offered:** Fall, Spring  
**Prerequisites:** Biol 105 and Biol 106, Permission of instructor

**BIOL 493 - Independent Study in Biology**

Course provides opportunity for a junior or senior biology major to engage in an independent study project in an area of mathematics in which the student has special interest.

**Credits Awarded:** 1-4  
**Terms Offered:** As Needed  
**Prerequisites:** Permission of Instructor

**BIOL 495 - Advanced Topics in Biology**

A special course, sometimes taught as a seminar, which deals with a specific area of biology at an advanced level. Past topics have included environmental genetic theory, the biology of sex, the heart and kidney, cancer biology, ecology of plant-animal interactions, and cholesterol biology.

**Credits Awarded:** 1-4  
**Terms Offered:** Fall, Spring  
**Prerequisites:** Biol 105 and Biol 106

**BIOL 499 - Internship**

An opportunity to gain practical experience in the work place. Requires formal application and permission of the department chairperson.

Credits Awarded: 1-6

Terms Offered: Fall, Spring, Summer

Prerequisites: Biol 105 and 106

**FACULTY****Barney, Dr. Christopher**

*The T. Eliot Weier Professor of Biology (1980)*

Ph.D., Indiana University Bloomington, 1977

B.S., Wright State University, 1973

**Best, Dr. Aaron**

*Harrison C. and Mary L. Visscher Professor of Genetics (2004)*

Ph.D., University of Illinois Urbana, 2001

M.S., University of Illinois Urbana, 1999

B.A., William Jewell College, 1996

**Brady, Dr. Allen**

*Retired Faculty (1966)*

**Bultman, Dr. Tom**

*Professor of Biology (2001)*

Ph.D., Arizona State University, 1985

M.S., University of Cincinnati, 1981

B.A., Hope College, 1978

**Burnatowska-Hledin, Dr. Maria**

*The Frederick Garrett & Helen Floor Dekker Professor of Biomedicine & Chemistry (1992)*

Ph.D., McGill University, 1980

M.S., McGill University, 1977

B.S., McGill University, 1975

**Chase-Wallar, Dr. Leah**

*Associate Professor of Biology & Chemistry (2000)*

Ph.D., Univ of Minnesota Twin Cities, 1999

B.S., University of Michigan-Flint, 1993

**Fraley, Dr. Gregory**

*Professor of Biology (2004)*

Ph.D., Washington State Univ, 1998

M.S., Univ Maryland College Park, 1992

B.S., Univ Maryland College Park, 1989

**Fraley, Dr. Susan**

*Lecturer in Biology (2013)*

**Greij, Dr. Eldon**

*Associate Professor (1962)*

Ph.D., Iowa State University,

**Griffin, Dr. Gerald**

*Assistant Professor of Psychology and Biology (2015)*

Ph.D., University of Pennsylvania, 2009

B.A., Cornell University, 2003

**Isola, Dr. Vicki**

*Assistant Professor of Biology (1988)*

Ph.D., University of Pennsylvania, 1988

B.S., Michigan Tech University, 1981

**Kopek, Dr. Benjamin**

*Assistant Professor of Biology (2014)*

Ph.D., University of Wisconsin, 2008

B.A., Spring Arbor University, 2002

**Li, Dr. Jianhua**

*Associate Professor of Biology (2009)*

Ph.D., Univ New Hampshire Durham, 1997

M.S., Huazhong Normal University, 1987

B.S., Henan University, 1984

**McDonough-Stukey, Dr. Virginia**

*Associate Professor of Biology and Department Chair (1995)*

Ph.D., Rutgers Univ New Brunswick, 1992

B.S., Rutgers Univ New Brunswick, 1983

**Muilenburg, Dr. Vanessa**

*Lecturer/Biology (2013)*

**Murray, Dr. Greg**

*Professor of Biology (1986)*

Ph.D., University of Florida, 1986

M.S., Calif State Univ Northridge, 1980

B.A., Calif State Univ Northridge, 1977

**Scogin, Dr. Stephen**

*Assistant Professor of Biology and Education (2014)*

Ph.D., Texas A&M Univ College Sta\*, 2014

M.S., Stephen F Austin State Univ, 1995

B.S., Stephen F Austin State Univ, 1993

**Stukey, Dr. Joseph**

*Assistant Professor of Biology (2000)*

Ph.D., Rutgers Univ New Brunswick, 1990

B.A., Rutgers Univ New Brunswick, 1981

**Vollbrecht, Dr. Pete**

*Visiting Assistant Professor of Biology (2005)*

Ph.D., Vanderbilt University, 2014

B.S., Hope College, 2007

**Winnett-Murray, Dr. Kathy**

*Professor of Biology (1986)*

Ph.D., University of Florida, 1986

M.S., Calif State Univ Northridge, 1979

B.S., University of Calif Irvine, 1976

# GEOLOGY

The geological sciences play a key role in addressing environmental problems, recognizing and mitigating natural hazards, and procuring natural resources. Furthermore, geoscientists make important contributions to human knowledge in fields as diverse as environmental geology, sustainability, oceanography, planetology, geochemistry, geophysics, plate tectonics and paleontology.

## ABOUT THE PROGRAM

Student-faculty research comprises an important part of the geology program at Hope College. In recent years students and faculty have been engaged in research projects such as:

- Experimental investigations on the remediation of contaminated ground water
- Analyzing trace element chemistry of phosphate minerals
- Working out the geological history of coastal dunes along Lake Michigan
- Making 3D computer models and gigapixel panoramas from digital photos to study dune erosion
- Exploring the effectiveness of biochar as a means to improve poor quality soils
- Investigating antibiotics and hormones in local ground water and surface water
- Uncovering the development of early continental crust in India and Sweden
- Documenting the occurrence and abundance of insects in ground water

Traditionally, the training of geologists has included a large amount of field experience. Hope College is ideally situated to study glacial geology, sedimentology, geomorphology, limnology and environmental issues. To broaden the spectrum of field experience, students commonly take longer trips to examine the geology of other areas such as the Upper Peninsula of Michigan, the Smoky Mountains of Tennessee, and the Ohio River Valley in Indiana and Kentucky. In addition to these trips, each year the regional geology field trip gives students the opportunity to visit and investigate the geology of a North American region. In the past, regional field trips have gone to the Colorado Plateau; Big Bend, Texas; Death Valley, California; Southern Arizona; New Mexico; and the Bahamas.

We are well-equipped for teaching and research. In addition to petrographic microscopes, the department has a geographic information system (GIS) computer laboratory, X-ray diffractometer, thin section preparation laboratory, ion chromatograph, gas chromatograph, infrared Fourier transform spectrometer, UV-visible light spectrometer and access to a scanning electron microscope.

The study of the Earth is eclectic so geologists must be competent in the other natural sciences and in mathematics. Accordingly, we encourage strong minors in other sciences and composite majors with chemistry and physics.

The Department of Geological and Environmental Sciences has an established reputation of excellence. Many graduating seniors have gone directly to work in environmental consulting firms, mineral resource companies, or the energy industry, while others have been accepted at some of the most prestigious graduate programs in the country, including the California Institute of Technology, University of Chicago, Harvard, Stanford, Princeton and various Big Ten universities.

## MAJORS

### Bachelor of Arts Degree in Geology

The Bachelor of Arts in Geology consists of one of the following sequences of introductory courses:

**Introductory Sequence #1** GES 100 – The Planet Earth, 4 credits and GES 111 – How The Earth Works, 2 credits or

**Introductory Sequence #2** GES 125 - Geology in the Field, 4 credits and GES 111 - How the Earth Works, 2 credits

together with the following courses:

- GES 203 – Historical Geology, 4 credits
- 16 total credits of geology courses selected from GES 225, GES 243, GES 244, GES 251, GES 252, Ges 320, GES 351, GES 430, GES 450, GES 453 or GES 295
- GES 341 – Regional Field Study, 2 credits
- One year, 8 credits, of ancillary science – Biology, Chemistry, Engineering, Environmental Science, or Physics

### Bachelor of Science Degree In Geology

The Bachelor of Science in Geology consists of one of the following sequences of introductory courses:

**Introductory Sequence #1** GES 100 – The Planet Earth, 4 credits and GES 111 – How The Earth Works, 2 credits or

**Introductory Sequence #2** GES 125 – Geology in the Field, 4 credits and GES 111 – How The Earth Works, 2 credits

together with the following courses:



- GES 203 – Historical Geology, 4 credits
- 24 total credits of geology courses selected from GES 225, GES 243, GES 244, GES 251, GES 252, GES 320, GES 351, GES 430, GES 450, GES 453 or GES 295
- Two semesters of GES 341 – Regional Field Study, 2 credits apiece for a total of 4 credits
- Two years, 16 credits, of ancillary sciences – biology, chemistry, engineering, environmental science, or physics and one year, 8 credits of mathematics (Calculus preferred). Both years of ancillary science need not be in the same science. *Students should choose these courses in consultation with their departmental advisors.*
- Students receiving a Bachelor of Science degree are also required to work on an independent research project with a faculty mentor.

### Geology Chemistry Composite

The composite major is an alternative to the departmental major. While the composite major seeks to fulfill the same objectives as the departmental major, namely, the ability to engage in intensive, in-depth scholarly inquiry, the composite major allows for special alignment of courses from several departments to fulfill a particular academic or vocational objective. The composite major is just as rigorous as a department major, but it allows the tailoring of an academic program to a field or topic of inquiry other than a departmental field. For additional information, please refer to the [Degree section](#) of the catalog.

### Geology Education

In partnership with the Department of Education, the Department of Geological and Environmental Sciences offers a Geology/Earth Science teaching major through the State of Michigan. The Michigan Certification Code requires that prospective high school teachers complete 30 or more credits of courses in geology for a major. Consult with the Department of Education concerning detailed requirements.

### Geology-Physics Composite

This was the first composite major established in the sciences at Hope College. Both the geology-chemistry and geology-physics majors have been very successful. Students who graduate with the composite major are in great demand and have been accepted into top graduate schools in the United States. You will find additional information about composites [here](#).

## MINORS

### Environmental Science

The Department of Geological and Environmental Science administers the environmental science minor, which is described in detail [here](#).

### **Geology**

A geology minor consists of at least 16 credits, not more than half of which may be numbered 203 or below.

### **Geology Education**

In partnership with the Department of Education, the Department of Geological and Environmental Sciences offers a geology/Earth science teaching minor through the State of Michigan. The Michigan Certification Code requires that prospective high school teachers complete 22 credits in geology for a minor. Consult with the Department of Education concerning detailed requirements.

## COURSES

### GEOLOGICAL/ENVIRONMENT SCIENCE

#### GES 125 - Michigan Field Geology

This course is designed as a hands-on introduction to the broad scope of geology using phenomena found within the state of Michigan. Its goal is to give students direct experience with the ways geoscientists ask and answer questions about the Earth. The class begins with a 10-day field trip during which students will travel, camp, and observe and interpret a variety of sedimentary, igneous, and metamorphic rocks and processes that affect them. The course finishes work at Hope College to further understand processes encountered in the field. This course is one possible introduction to the geology major. A 10-day August field trip is required. A student may not receive credit for both GES 100/GEMS 157 and GES 125.

Terms Offered:

Attribute: ADDITIONAL COURSE FEE, Natural Science I with lab (+FEE, NSL)

### ENVIRONMENTAL SCIENCE COURSES

#### GES 211 - Earth Environmental Systems I

This is the scientific study of our planet in terms of natural systems and their mutual interaction, with an emphasis on the modification of these systems by human activities. The emphasis in this course is on local-scale environmental problems. Subjects covered include air pollution modeling, fate and transport of water pollution, contaminant toxicology, risk assessment, soil chemistry, and soil degradation. Three hours of lecture per week.

Credits Awarded: 3

Terms Offered: Fall

Prerequisites: Chem 125 or Chem 131 or permission of instructor

#### GES 493 - Independent Study: Geol/Enviro

Terms Offered:

#### GES 212 - Earth Environmental Systems II

This is the scientific study of our planet with an emphasis on global environmental problems. Subjects covered include population and demographics, basic ecological principles, biological diversity, extinction, natural resources, sustainability, biogeochemical cycles, climate and climate change, and ozone depletion. Three hours of lecture per week.

Credits Awarded: 3

Terms Offered: Spring

Prerequisites: Chem 125 or Chem 131 or permission of instructor

**GES 220 - Laboratory Methods in Environmental Science**

This laboratory course accompanies Ges 211 and Ges 212. This class will introduce laboratory and field methods necessary to investigate the natural systems which comprise our ecosystem, and the effects of human activities on it. Sampling techniques, field identification, and common methods of chemical analysis for environmental study will be emphasized. Three hours of laboratory per week and one hour of discussion.

**Credits Awarded:** 2

**Terms Offered:** Spring

**Prerequisites:** Chem 127 or Chem 132

**GES 310 - Environmental Public Policy**

This course is an introductory analysis of the economic, scientific and political factors involved in environmental public policy. American environmental management will be viewed in terms of the interplay among economic efficiency, scientific feasibility and the demands of the political process. Topics covered will include federal lands, intergovernmental relations, agency law, comparative institutions, U.S. environmental regulations and technological compliance. This course is team taught by faculty from the Departments of Economics, Geological and Environmental Sciences, and Political Science so that students are exposed to the interdisciplinary nature of environmental public policy issues. Four hours of lecture per week. Fulfillment of the NSL lab requirement is highly recommended prior to this course.

**Credits Awarded:** 4

**Terms Offered:** Spring

**Prerequisites:** Econ 211 with a grade of C- or better or Pol 100

**GEOLOGY COURSES****GES 401 - Advanced Environmental Seminar**

This is an interdisciplinary course where students with different academic majors will work in teams to research a local environmental problem. The students will work with faculty members in geological/environmental sciences, biology, chemistry, and possibly other departments in the design of a research project, the collection and interpretation of data, and the making of recommendations. This course is meant to duplicate the process by which scientists work to solve actual environmental problems and is intended as a "capstone" experience for environmental science minors. One two-hour group meeting per week. Additional times to be arranged for consultation, field and laboratory work.

**Credits Awarded:** 2

**Terms Offered:** Fall

**Prerequisites:** Ges 211 or Ges 212 or Ges 220

**GES 100 - The Planet Earth**

This course is an introduction to the scientific study of the planet on which we live. This course emphasizes the study of the major Earth systems (atmosphere, hydrosphere, biosphere, and geosphere) and the interactions between them. Attention is given to environmental change and its implications for our future. This course is one possible introduction to the geology major. Three lectures and one three-hour laboratory each week. One or two Saturday morning field trips are required. Cross-listed as Gems 157. A student may not receive credit for both Gems 157/Ges 100 and Ges 110.

Credits Awarded: 4

Terms Offered: Fall, Spring

Attribute: Natural Science I with lab (NSL)

**GES 104 - Organisms and Environments**

This is the second of a two-semester sequence of courses. The combined courses ("Matter and Energy" and "Organisms and Environments") will satisfy the natural science laboratory general education requirements only for elementary education teacher candidates. The courses will also cover the content that is important for future educators in an integrated inquiry-based format. The content in this recommended course sequence will flow from physical science to Earth/space science to life science topics that students will find themselves teaching in the future. This course will primarily include content from the life and Earth/space sciences, though due to the interdisciplinary nature of many of the topics, physical science topics will also be addressed where appropriate.

Credits Awarded: 4

Terms Offered: Fall, Spring

Attribute: Natural Science I with lab (NSL)

**GES 111 - How The Earth Works: An Introduction to Plate Tectonics**

Plate tectonics is a theory that has revolutionized geology, giving the science its first coherent, widely accepted picture of how the whole Earth works. This course is designed to give students a solid understanding of the basic theory, the evidence on which it is based, and its application to subjects as diverse as earthquakes, volcanoes, mountain ranges, precious metal deposits, the topography of the sea floor, and the history of life.

Credits Awarded: 2

Terms Offered: Fall

**GES 203 - Historical Geology**

This is an introduction to the physical and biological development of the Earth during the last 4.5 billion years. Topics include the formation of the Earth, interpretation of major events in Earth history as preserved in the rock record, and the origin and evolution of life. Three lectures and one three-hour laboratory each week. One weekend field trip is required.

Credits Awarded: 4

Terms Offered: Spring

Prerequisites: Ges 100 or Gems 157 or Ges 111, or permission of instructor

**GES 225 - Introduction to Geographic Information Systems**

This course introduces principles and tools for using a Geographic Information System to display and analyze location-based data, along with instruction on where to find freely available data and how to create new datasets. Concepts will include scale, map projections, raster- and vector-based representations of data, and evaluation of spatial relationships between features. Students will receive hands-on instruction with ArcGIS software to learn how to create and analyze maps of any kind of data with a geographic component. Exercises will focus on analysis of real-world datasets to solve problems of local interest.

Credits Awarded: 2  
Terms Offered: Spring

**GES 243 - Mineralogy: Earth Materials I**

This course is an introduction to the paragenesis and crystal chemistry of minerals with emphasis on the rock-forming silicates. Laboratory periods will be devoted to the study of minerals in hand samples, as well as exercises designed to help the student understand physical and chemical properties of minerals. Three lectures and one three-hour laboratory per week. One weekend field trip will be required. Students may take Chem 125 or Chem 131 prior to enrollment in or concurrently with the course.

Credits Awarded: 4  
Terms Offered: Fall, Even Years  
Prerequisites: Chem 125 or Chem 131 or permission of instructor  
Corequisites: Chem 125 or Chem 131

**GES 244 - Petrology: Earth Materials II**

This is a course about mineralogical, chemical, and textural characteristics of igneous, sedimentary, and metamorphic rocks. Their occurrence and petrogenesis will be discussed in terms of rock associations and relevant physical and chemical processes of formation. Laboratory sessions will be devoted to petrographic description, identification, and interpretation of rocks in hand samples and microscope thin sections. A Saturday field trip is required. Three one-hour lectures and one three-hour laboratory per week.

Credits Awarded: 4  
Terms Offered: Spring, Odd Years  
Prerequisites: Ges 243

**GES 251 - Surficial Geology: Earth Structures I**

This is an introduction to the natural processes shaping Earth's surface. Among other topics, the course will stress weathering, landform and soil development, soil mechanics, the influence of running water, moving ice and wind on Earth's surface, and people's interaction with surficial geology. The laboratory will emphasize the use of maps and other geographic images and the course will include an introduction to mapping. Three lectures and one three-hour laboratory each week. Two Saturday field trips will be required.

Credits Awarded: 4  
Terms Offered: Fall

**GES 252 - Structural Geology: Earth Structures II**

This is a study of the structures formed by rock deformation, stressing geometric techniques and the concept of strain. The laboratory will emphasize the preparation and interpretation of geological maps and cross-sections. Three hours of lecture and one three-hour laboratory each week. One weekend field trip is required.

Credits Awarded: 4  
 Terms Offered: Spring, Even, Years  
 Prerequisites: Ges 251 or permission of instructor

**GES 295 - Special Topics in Geology**

A course offered in response to student and instructor interest. Topics are not generally covered in the regular course listings. Course may be taken multiple times if topics are different.

Credits Awarded: 0-4  
 Terms Offered: As Needed  
 Prerequisites: Permission of instructor

**GES 320 - Introduction to Petroleum Geology**

This course is an introduction to the applied sub-discipline of geology called petroleum geology. Emphasis is placed on the techniques and strategies used in the modern energy industry to find, extract and produce petroleum hydrocarbons. Topics will include depositional environments, subsurface mapping, seismic interpretation, wire-line logging, reservoir characterization, onshore and offshore leasing, and exploration economics. Student will gain experience working individually and on teams in the evaluation of subsurface data and the development of exploration-related strategies.

Credits Awarded: 4  
 Terms Offered: Spring, alternate years  
 Prerequisites: Ges 100 or Gems 157 or Engs 100, or permission of instructor

**GES 341 - Regional Field Study**

This course is a field investigation of the general geology of an area selected by the instructor. One or more hours of lecture will be held each week prior to study in the field. The entire spring vacation or an extended period in the spring or summer will be spent in the field. Courses may be repeated for credit if fieldwork is conducted in different regions.

Credits Awarded: 2  
 Terms Offered: Spring  
 Prerequisites: Ges 100 or Gems 157 or Ges 110 or Ges 111, or permission of instructor

**GES 351 - Invertebrate Paleontology**

This is the study of the fossil record of the history of invertebrate life. Topics include changes in diversity during the Phanerozoic, tempo and mode of evolution, functional morphology, systematics, and paleoecology of the major invertebrate phyla. Three hours of lectures and one three-hour laboratory per week. One or more weekend field trips will be required.

Credits Awarded: 4  
 Terms Offered: Fall, Even Years  
 Prerequisites: Ges 203 or permission of instructor

**GES 430 - Environmental Geochemistry**

The principles of physical and inorganic chemistry will be applied to geochemical systems of environmental interest. Element recycling and evaluation of anthropogenic perturbations of geochemical cycles will be examined with a strong emphasis on aqueous chemistry. Laboratory exercises will emphasize computer modeling and the analyses of natural waters by a variety of techniques. Three lectures each week. This is a flagged course for the Environmental Science minor.

Credits Awarded: 4  
 Terms Offered: Spring, Odd Years  
 Prerequisites: Chem 331 or Ges 243

**GES 450 - Hydrogeology**

This is a study of the geological aspects of the water cycle with an emphasis on groundwater. Topics include aquifer testing, groundwater flow, geology of aquifers, water resource management, groundwater chemistry, contamination, and remediation. Emphasis is placed on quantitative problem solving. Three hours of lecture and one three-hour laboratory each week. This is a flagged course for the Environmental Science minor.

Credits Awarded: 4

Terms Offered: Spring, Even Years

Prerequisites: Permission of instructor

**GES 453 - Sedimentology**

This is the study of the mineralogy, petrology, occurrence, and stratigraphic associations of sedimentary rocks. Thin section examination, textural analysis, and field investigation of sedimentary rocks and unconsolidated sediments will be performed in the laboratory. Three hours of lecture and one three-hour laboratory each week. One or more weekend field trips will be required.

Credits Awarded: 4

Terms Offered: Fall, Odd Years

Prerequisites: Ges 203 or permission of instructor

**GES 490 - Special Problems**

This course is designed to introduce the student to research. A research problem in an area of special interest will be nominated by the student, and approved by a faculty member who will oversee the research.

Credits Awarded: 0-3

Terms Offered: Fall, Spring, Summer

Prerequisites: Permission of instructor

**GES 495 - Study in Geology**

In this course a professor guides students in scholarly readings and discussions focused on a special area of geologic interest.

Credits Awarded: 1-2

Terms Offered: Fall, Spring, Summer

**FACULTY****Bodenbender, Dr. Brian**

*Professor of Geology & Environmental Science and Department Chair (1996)*

Ph.D., University of Michigan, 1994

M.S., University of Michigan, 1990

B.A., College of Wooster, 1987

**DeVries-Zimmerman, Suzanne**

*Adjunct Assistant Professor of Geological & Environmental Science (1999)*

M.A., Princeton University, 1989

B.A., Hope College, 1986

B.S., Hope College, 1982

**Hansen, Dr. Edward**

*Professor of Geology & Environmental Science (1984)*

Ph.D., University of Chicago, 1983

B.S., University of Cincinnati, 1978

**Peaslee, Dr. Graham**

*The Elmer E. Hartgerink Professor of Chemistry/Professor of Geology/Env Science (1993)*

Ph.D., Stony Brook University Suny, 1987

B.A., Princeton University, 1981

**Peterson, Dr. Jonathan**

*The Lavern '39 and Betty DePree '41 Van Kley Professor of Geology & Env Science (1994)*

Ph.D., University of Chicago, 1989

B.A., Hope College, 1984

**VanDyken, Matthew**

*Lecturer in Geological and Environmental Science (2012)*



# ENVIRONMENTAL SCIENCES

Students in the environmental science program use scientific approaches to address environmental problems. When they complete the program, they earn an environmental science minor.

## ABOUT THE PROGRAM

The environmental science minor is open to all students regardless of their major, but it is best suited for those who have a strong interest in science or engineering. Students should complete a semester of chemistry before taking courses in environmental science. Chemistry may be taken concurrently with permission of the instructor. The environmental science minor is administered through the Department of Geological and Environmental Sciences.

Our ability to modify our environment has increased dramatically over the last century, and we now recognize that many of those modifications have negative consequences. A growing number of scientists seek solutions to environmental problems as they work to improve our understanding of the causes, processes and consequences of environmental change. The "typical" environmental scientist is a specialist in one of the traditional disciplines such as biology, chemistry, geology, physics or engineering. However, he or she generally has a broad scientific understanding of environmental systems that goes beyond the confines of his or her discipline, including an understanding of how environmental issues affect and are affected by politics and economics. An environmental scientist will often work in a team with professionals from other fields to study and solve environmental problems.

## MINORS

The environmental science minor helps students acquire the background they need to be successful environmental scientists or, for those not majoring in science, to use skills learned in their own major to work closely with environmental scientists.

### Environmental Sciences

The environmental science minor has the following goals for its students:

**Goal #1:** A solid preparation in one of the academic majors at Hope College.

**Goal #2:** An understanding of the perspective this discipline brings to environmental science. To meet this goal, students are required to take two courses that have been flagged as relevant to environmental science.

It is anticipated that in most cases these flagged courses will be within the student's major and will fulfill part of the requirements for this major. Flagged courses for selected majors include:

# ENVIRONMENTAL STUDIES

## ABOUT THE PROGRAM

The goals of the environmental studies program are to:

1. Increase understanding of how the world as a bio-physical system works, foster awareness of the earth's vital signs and sharpen the ability of students to understand the nature and results of science
2. Encourage a critical understanding of the various historical, political, economic, ethical, and religious forces that have shaped and continue to shape our world
3. Nurture an ecological frame of mind which is willing and able to see things whole and thus resist the narrow specialization that can blind us to the connections between disciplines and bodies of knowledge
4. Cultivate people who have sufficient knowledge, care and practical competence to live in an ecologically responsible way
5. Provide opportunities for students to explore the connections between environmental issues and different religious and philosophical traditions, and to encourage students who are Christian to reflect on their faith and its vision of shalom.

## MINORS

The student who minors in environmental studies may major in anything. For students who major in one of the natural sciences, one of the environmental studies GEMS courses may be replaced by other appropriate science courses, with the permission of the program director. For a student who decides to minor in both environmental science and environmental studies, such a double minor does not constitute a major.

### Environmental Studies

The minor consists of a minimum of 20 credits.

- Eight credits are required in the natural sciences, with courses taken from a particular set of GEMS courses.
- At least four credits must be met by one of the lab-based GEMS courses.
- Four credits are required in the social sciences: either Environmental Sociology, Environmental Public Policy, or Managing for Environmental Sustainability.
- Four credits are required in the humanities: either American Literature and the Environment or Environmental Philosophy and History.

- The final four credits are part of a senior integration experience: a two-credit research project and a two-credit internship in a local business, non-profit organization, governmental agency, or educational institution.

In addition to the courses in the minor, there are a number of general education courses that address various environmental issues and themes and thus may be of special interest for environmental studies students.

## Requirements

### Required Courses (20 credits)

1. Natural Sciences: choose 8 credits from the following courses

GEMS 152: The Atmosphere and Environmental Change, 4 credits

GEMS 153: Populations in Changing Environments, 4 credits

GEMS 157: The Planet Earth, 4 credits

GEMS 160: The Chemistry of Our Environment, 4 credits

GEMS 204: Regional Flora and Fauna, 2 credits

GEMS 295: Abrupt Climate Change, 2 credits

2. Social Sciences: choose 4 credits from the following courses

SOC 295: Environmental Sociology, 4 credits

GES 310: Environmental Public Policy, 4 credits

MGMT 356: Managing for Environmental Sustainability, 4 credits

3. Humanities: choose 4 credits from the following courses

ENGL 375: American Literature and the Environment, 4 credits

ENVR 377: Environmental Philosophy and History, 4 credits

4. Senior Integration Experience: 4 credits

ENVR 490: Research Project, 2 credits

ENVR 499: Internship, 2 credits (minimum)

### Thematically Related Courses in the Core Curriculum

IDS 100: First Year Seminar, 2 credits

The topics will vary depending on the section, but there may be sections a focus on environmental themes.

REL 100: Earth and Ethics, 2 credits

ENGL 113: Expository Writing, 4 credits

The topics will vary depending on the section, but there may be sections with a focus on environmental themes.

REL 369: Ecological Theology and Ethics, 4 credits

IDS 467: God, Earth, Ethics, 4 credits

## COURSES

### ENVIRONMENTAL STUDIES

#### **ENVR 295 - Topics Environmental Studies**

A course offered in response to student and instructor interest. Topics are not generally covered in the regular course listings. Course may be taken multiple times if topics are different.

Credits Awarded: 1-4  
Terms Offered: As Needed

#### **ENVR 377 - Environmental Philosophy and History**

An in-depth study of classic and contemporary texts in environmental philosophy and history, including primary sources by Plato, Aristotle, Descartes, Locke, Thoreau, Berry, Carson, and Leopold, as well as secondary studies by Crosby, Ponting, and Steinberg.

Credits Awarded: 4  
Terms Offered:  
Prerequisites: Cultural heritage core

#### **ENVR 395 - Topics Environmental Studies**

A course offered in response to student and instructor interest. Topics are not generally covered in the regular course listings. Course may be taken multiple times if topics are different.

Credits Awarded: 1-4  
Terms Offered: As Needed

#### **ENVR 490 - Research Project**

An in-depth investigation of some issue or problem of the student's choosing. Instructor: environmental studies faculty. Prerequisites: all courses in the minor, except the internship

Credits Awarded: 0-3  
Terms Offered: Spring, Fall  
Prerequisites: Permission of instructor

#### **ENVR 493 - Independent Study in Environmental Studies**

An independent study project investigating an issue or problem of the student's choosing.

Credits Awarded: 1-4  
Terms Offered: As Needed  
Prerequisites: All minor requirements except for internship

#### **ENVR 499 - Internship**

A supervised practical experience in a local work setting, e.g., business, non-profit organization, governmental agency, educational institution.

Credits Awarded: 2-4  
Terms Offered: Fall, Spring  
Prerequisites: All minor requirements except for research project

## FACULTY

#### **Bouma-Prediger, Dr. Steven**

*Professor of Religion, Associate Dean for Teaching and Learning (1994)*

Ph.D., University of Chicago, 1992

M.Div., Fuller Theological Seminary, 1987

MPHI, Institute Christian Studies, 1984

B.A., Hope College, 1979

- BIOL 301 – Microbiology
- BIOL 315 – Ecology
- BIOL 343 – Plant Systematics
- BIOL 356 – Genetics
- BIOL 422 – Invertebrate Zoology
- BUS 341 – Business Law
- CHEM 331/332 – Analytical Chemistry and Laboratory
- Chemistry: Environmental Geochemistry or a second chemistry course chosen in consultation with the Chemistry Department chairperson
- ECON 212 – Microeconomics
- ENGS 140 – Introduction to Electric Circuits
- ENGS 150 – Conservation Principles
- ENGS 346 – Fluid Mechanics
- GES 225 – Geographic Information Systems
- GES 430 – Environmental Geochemistry
- GES 450 – Hydrogeology
- MATH 361/363 – Introduction to Probability and Lab
- MATH 362/364 – Mathematical Statistics and Lab
- PHYS 270 – Modern Physics
- PHYS 382 – Advanced Laboratory: students must take a semester which involves radiation
- Political Science – Two courses chosen in consultation with the Political Science Department chairperson

**Goal #3:** A broad interdisciplinary understanding of environmental science. Students are required to take two interdisciplinary courses in environmental science, consisting of GES 211 – Earth Environmental Systems I (Fall Semester, 3 credits), and GES 212 – Earth Environmental Systems II (Spring Semester, 3 credits). These may be taken in any order.

**Goal #4:** Knowledge of how environmental issues affect and are affected by politics and economics. Students meet this goal by taking GES 310 – Environmental Public Policy, 4 credits. This is an interdisciplinary course taught by faculty in the Natural Science Division, Political Science Department and/or Department of Economics.

**Goal #5:** An ability to work in a team with scientists and non-science professionals from other disciplines. To obtain experience with technical aspects of environmental science, students take GES 220 – Laboratory Methods in Environmental Science, 2 credits. Students are also required to take GES 401 – Advanced Environmental Seminar, 2 credits. In this capstone course they work with students and faculty from a number of disciplines to study a local environmental problem.

**Goal #6:** An ability to use principles of sustainability when considering environmental problems and solutions. This is introduced formally in GES 212 and incorporated throughout the minor's other course offerings.

In summary, the environmental science minor consists of:

1. Two flagged courses which may also satisfy requirements for the student's major
2. GES 211 – Earth Environmental Systems I
3. GES 212 – Earth Environmental Systems II
4. GES 220 – Laboratory Methods in Environmental Science
5. GES 310 – Environmental Public Policy
6. GES 401 – Advanced Environmental Seminar

### **Environmental Science Courses**

The environmental science minor is administered through the Department of Geological and Environmental Sciences. Descriptions of each of the GES courses listed above are found under the heading of Environmental Science Courses in the [Geology](#) section of the catalog.

## **FACULTY**

### **Bodenbender, Dr. Brian**

*Professor of Geology & Environmental Science and  
Department Chair (1996)*

Ph.D., University of Michigan, 1994

M.S., University of Michigan, 1990

B.A., College of Wooster, 1987