The general education requirements for natural science are met by taking a minimum of 10 credits in the division, at least four of which must be a lab-based natural science course and at least two of which must be in mathematics.

**ABOUT THE PROGRAM**

It is anticipated that most students majoring in the natural sciences or mathematics will accomplish this by taking department courses. However, for the students not majoring in natural science or mathematics, GEMS are courses designed to fulfill their natural science general education requirements. The purpose of these courses is to build an understanding of the scientific and mathematical ways of knowing about the world appropriate for an educated person living in a scientific and technical age. GEMS courses fall into three categories: mathematics courses; four-credit, interdisciplinary, laboratory-based science and technology courses; and two-credit topical science and technology courses. Hope College has been nationally recognized for its GEMS program by the American Association of Colleges and Universities and support for these courses has been provided by the National Science Foundation.

**Mathematics Courses (GEMS 100-149)**

Mathematical thinking and reasoning permeate our society. GEMS mathematical courses are designed to expose students to both the power and limitations of mathematics, particularly of mathematical modeling. Each course will focus on at least one of the two ways in which quantitative information is frequently conveyed: statistics and graphs. These courses are designed to broaden a student's perception of the nature of mathematics as an ongoing endeavor, as well as to give him or her a sense of the historical roots of significant mathematical discoveries. Above all, through these courses students should gain a sense of the aspects of mathematics which make it unique as a "way of knowing."

**Four-Credit Interdisciplinary Science and Technology Courses (GEMS 150-199)**

Natural scientists study the physical world and propose answers to questions which are tested against reproducible direct observations or experiments. All scientific studies share some approaches, which are commonly referred to as the scientific method. However, because there are many different approaches employed in answering scientific questions, it is probably more useful to think in terms of scientific methods rather than a single method. The four-credit science and technology courses are interdisciplinary so that students will employ several of these scientific ways of knowing, yet experience the nature of scientific inquiry common to all disciplines. These courses have both laboratory and classroom components, and include out-of-class readings and library-based research.
Two-Credit Topical Science and Technology Courses (GEMS 200-250)

These courses build on skills acquired in the four-credit laboratory-based science courses to provide a focused experience in scientific inquiry. The two-credit courses are both topical and investigative. Students will be expected to gain a mastery of a scientific topic through hands-on investigations, and to communicate their knowledge through a variety of media. The goal of these courses is to provide models for life-long learning in science and technology by introducing students to how-to techniques for learning and mastering a particular scientific subject through inquiry. These courses meet for half a semester for up to six total hours per week.
COURSES

GEN EDUCATION MATH & SCIENCE

GEMS 100 - Understanding Our Quantitative World
This is a two-credit, half-semester course whose main emphasis is on the ability to critically interpret mathematical information commonly found in public discourse and positions of responsibility and leadership. The topics will include simple functions, graphs and their interpretation, and statistics. Examples incorporating mathematical arguments will be taken from a wide variety of fields including social science, sports, finance, environmental issues, education and health. The TI-83 graphing calculator will be required.

Credits Awarded: 2
Terms Offered: Fall, Spring
Attribute: Mathematics I (MA1)

GEMS 105 - Nature of Mathematics
This is a two-credit, half-semester course whose main emphasis is the discussion and exploration of the “great ideas” in mathematics, particularly those that have occurred in the last 100 years. The format of the course will be primarily discussion and lecture, with some group activities. Topics include mathematical puzzles, patterns within numbers, bar codes and secret codes, the concept of infinity, and chaos and fractals.

Credits Awarded: 2
Terms Offered: Fall, Spring
Attribute: Mathematics I (MA1)

GEMS 130 - Introduction to Environmental Science
This course introduces students to systems thinking, to concepts of the physical world essential for the study of environmental science, and to sustainability as a lens for considering issues of resource production, resource consumption, and generation of waste. Laboratory exercises will explore general scientific principles relevant to study of the atmosphere, oceans, and solid Earth, as well as aspects of resource use in our daily lives. Three lectures and one three-hour laboratory each week. Cross-listed with GES 130. No prerequisites.

Credits Awarded: 4
Terms Offered: Fall, Spring
Attribute: Natural Science I with lab (NSL)
GEMS 151 - Science and Technology for Everyday Life

Modern society would not exist without the aid of technology. We depend upon technological devices for communication, food production, transportation, health care and even entertainment. This course focuses on the wide variety of technology used in everyday life. The objective is to develop a familiarity with how various technological devices work, and to explain the basic scientific principles underlying their operation. Topics covered include: the automobile, radio, television, cellphones, microwave ovens, computers, ultrasound, and x-ray imaging. Concepts from basic science are introduced as they appear in the context of technology. Laboratory projects include construction of simple objects such as radios, electric motors, and a musical keyboard.

Credits Awarded: 4
Terms Offered: Fall, Spring
Attribute: Natural Science I with lab (NSL)

GEMS 152 - The Atmosphere and Environmental Change

Storms, droughts, heat waves, and cold snaps make us all aware of how the atmosphere impacts human beings. Recent concerns about the greenhouse effect, climate change, pollution, and ozone depletion have made us more aware of how human beings impact the atmosphere. The subject matter of this course is the effect of the atmosphere on people and of people on the atmosphere. Subjects will include the basics of the atmosphere and weather, local pollution, acid rain, climate change, ozone depletion, storms, droughts, and floods. GEMS 100 is highly recommended prior to or concurrently with this course, except for students who have received college credit for Math 126 or Math 131.

Credits Awarded: 4
Terms Offered: Fall
Attribute: Natural Science I with lab (NSL)

GEMS 153 - Populations in Changing Environments

In this investigation-based course students will explore the biological principles of population growth and dynamics, extinction and evolution, species interactions, biodiversity and conservation. Topics are studied within an environmental context using quantitative and experimental approaches. GEMS 100 is highly recommended prior to or concurrently with this course, except for students who have received college credit for Math 126 or Math 131.

Credits Awarded: 4
Terms Offered: Fall
Attribute: Natural Science I with lab (NSL)

GEMS 154 - Stars and Planets

A survey of planetary geology in our solar system, of stellar formation and evolution, and of galaxies of the physical universe. We will discuss what is known and how the knowledge is obtained. Topics include the telescope, Earth-Moon system, terrestrial and gaseous planets, the Sun, types of stars and their intrinsic properties, the H-R diagram, pulsars, neutron stars, black holes, galaxies, and cosmology. The course will include in-class cooperative assignments, lecture, homework and a laboratory. Various laboratory exercises include building a simple telescope and observing with it, learning and observing the constellations, weather and geology of the planets, observing Jupiter and measuring its mass and the masses of the four brightest moons, observing a cluster of stars and making a H-R diagram, a pulsar model, classification of galaxies, and Hubble’s law.

Credits Awarded: 4
Terms Offered: As Needed
Attribute: Natural Science I with lab (NSL)
**GEMS 155 - History of Biology & Lab**

Students will consider the historical development of biological knowledge from ancient times to the present. The lab will offer opportunities to recreate crucial experiments from the past, and we will then consider their historical and philosophical impact. Students will investigate the history of biology from a broad interdisciplinary perspective. While the scope of the course will be broad, it will focus on the development of biology in the 19th century when Darwin, Pasteur, Bernard, Mendel, and others were laying the groundwork of modern biology. One cultural heritage course is highly recommended prior to this course.

**Credits Awarded:** 4  
**Terms Offered:** As Needed  
**Attribute:** Natural Science I with lab (NSL)

**GEMS 157 - The Planet Earth**

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 solid Earth) and the interactions between them. Particular attention is given to the subject of environmental change and the implications for our future. One or two Saturday morning field trips are required. Cross-listed as Ges 100.

**Credits Awarded:** 4  
**Terms Offered:** Fall, Spring  
**Attribute:** Natural Science I with lab (NSL)

**GEMS 158 - Human Biology in Health and Disease**

Despite our differences, each of us has a body that functions to keep us alive. This course examines the structure and function of the human body from investigative and interdisciplinary perspectives. We will consider how the various organ systems work to maintain life and the ways in which the functions of these systems can be compromised by disease. Participants will explore how scientific methods are used to learn about the biology of humans. In addition to more traditional laboratory exercises, teams of students will design, carry out, and report on a laboratory project related to human biology. This course should be well-suited for students majoring in social work and other areas where a general understanding of human biology would be useful, as well as for students interested in learning more about human biology under normal and pathological conditions.

**Credits Awarded:** 4  
**Terms Offered:** Spring  
**Attribute:** Natural Science I with lab (NSL)
GEMS 159 - History of Science

This course surveys the history of science from the Renaissance to the present day. In addition to mastering the historical content, students will recreate historic experiments in order to understand scientific theories and methodologies as well as the nature of science itself. The primary objectives of the course are to understand how scientific knowledge expanded and changed over time, individuals developed and practiced the role of “scientist,” science influenced social environments, and social and political changes affected science, as well as why science developed as a particular kind of cross-disciplinary exploration of the universe with certain types of questions and methodologies. Cross-listed with Hist 159.

Credits Awarded: 4
Terms Offered: Fall
Attributes: Global Learning Domestic (GLD), Natural Science I with lab (NSL)

GEMS 160 - The Chemistry of Our Environment

This course will look at how chemistry, which is the study of matter and its changes at the molecular level, serves as the basis for understanding and predicting how our technological society impacts the environment in which we live. Basic chemical principles will be introduced and serve as building blocks to explain environmental phenomena we encounter in our everyday life. Laboratory investigations of environmental processes, together with case studies of environmental problems, will be used to build an understanding of the molecular nature of the world around us, and how we interact with it. Topics will include: testing for groundwater pollution, chemicals in the home, chemical manufacturing and recycling, and others. GEMS 100 or Math 205 is highly recommended prior to or concurrently with this course.

Credits Awarded: 4
Terms Offered: As Needed
Attribute: Natural Science I with lab (NSL)

GEMS 161 - Biotechnology and You

This course will explore basic concepts underlying recent biomedical developments that affect your everyday life and decisions you have to make. Topics will include genetic engineering, cloning, somatic cell research, drug resistance, bioterrorism, etc. The course will focus on interpretation of the scientific information we receive through the media. The laboratory projects will be designed to expose students first-hand to the technologies discussed in class.

Credits Awarded: 4
Terms Offered: As Needed
Attribute: Natural Science I with lab (NSL)
GEMS 163 - How Computers Work
This course provides an overview of the various layers that make up a modern computer system, including topics such as how computers represent and store information, how the various components of a computer work together to process information, the role of operating systems and computer networks, and basic algorithm design. In the laboratory components of the course, students use common everyday applications and computing tasks to help them connect the conceptual with the practical. The course will emphasize the social implications of the technologies that are covered. Credit cannot be given for both CSCI 112 and GEMS 163.

Credits Awarded:  4  
Terms Offered:  Fall  
Attribute: Natural Science I with lab (NSL)

GEMS 195 - Topics in General Education Mathematics and Science
A course offered in response to student and instructor interest.

Credits Awarded:  4  
Terms Offered:  As Needed  
Attribute: Natural Science I with lab (NSL)

GEMS 201 - Evolution of Dinosaurs
This course investigates the geological record and biology of dinosaurs. It provides an overview of current knowledge about dinosaurs as a framework for answering specific questions about their history, function, ecology, evolution, and portrayal in popular media. Case studies will examine such topics as warm-bloodedness and the evolutionary relationship between dinosaurs and birds. The course will culminate in a symposium where students present the results of library and analytical research.

Credits Awarded:  2  
Terms Offered:  Spring  
Attribute: Natural Science II (NS2)

GEMS 204 - Regional Flora and Fauna
This course will stress the identification, natural history, and ecological importance of the common plants and animals in the Great Lakes region. Students will be taking field trips to natural areas to learn about the flora and fauna first-hand. Practical aspects of natural history will be stressed such as wildlife watching, tree and wildflower identification, and insect biology.

Credits Awarded:  2  
Terms Offered:  Fall  
Attribute: Natural Science II (NS2)

GEMS 205 - The Science of Bread-making
This course will stress biological principles associated with bread-making. Some of these include: culturing yeast, fermentation, germination, aerobic respiration, and digestion of carbohydrates. Steps in the scientific method will be emphasized. Each student or group of students must conduct a scientific experiment on some aspect of bread-making. The experiment will culminate in a formal write-up and oral presentation.

Credits Awarded:  2  
Terms Offered:  As Needed  
Attribute: Natural Science II (NS2)
GEMS 206 - The Night Sky
The primary goal of this course is to understand the unique features of various astronomical objects in our night sky, such as bright stars, double stars, planetary nebulae, supernova remnants, emission nebulae, globular clusters, and galaxies. Through various hands-on activities, we will understand the day-to-day and annual changes in our night sky. About a third of the course involves field work in which we are able to make observations with the naked eye and by imaging objects using the Harry F. Frissel Observatory. We will learn what a star is by exploring stellar formation and evolution. A large collection of stars form a galaxy like our Milky Way. Yet galaxies fall into different classification groups that have specific characteristics.

Credits Awarded: 2
Terms Offered: Fall, Spring
Attribute: Natural Science II (NS2)

GEMS 295 - Topics in Science
A course offered in response to student and instructor interest. Recent offerings have included Exploring Computer Science (CSCI 112), Human Genetics, Abrupt Climate Changes, and sustainability.

Credits Awarded: 2-4
Terms Offered: As Needed

FACULTY & STAFF

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