Courses for Liberal Arts Majors that Satisfy the Core Requirement in the Natural Sciences

Astronomy
Biology
Chemistry
Environmental Studies
Physics

College of Liberal Arts and Sciences
Villanova University
2008-2009

Goals of Courses Satisfying the Core Curriculum Requirement in the Natural Sciences[1]

In order to increase interest in science and to promote science literacy, these courses present material and discuss issues that are timely, stimulating and relevant to the lives of the students (directly, indirectly, now and in the future). These courses also provide opportunities to use writing as a skill to understand the language and methods of science.

Like students majoring in the sciences, other students in the College of Liberal Arts and Sciences ("liberal arts students") have taken several years of high school science, but do not necessarily have an interest in science, or have (or have not discovered) talents for the skills that are necessary maintain or generate an active interest in science at the college level. Thus, in order to teach successful Core Science courses we especially need to teach or help to enhance:

- knowledge of fundamental scientific principles with broad application
- quantitative and computer skills at an appropriate level based on skills already acquired by all students in high school
- visualization (visual thinking) skills
- skills of deductive reasoning
- enthusiasm for simple curiosity
- an appreciation of the importance of accepting a new ways of looking at things if the data warrant a change in perspective.

In all of these courses, students will:

- learn about the structure and function of the natural world as elucidated by scientific discovery and experimental investigation.
- be able to use the vocabulary of science and to understand the basic concepts underlying scientific knowledge
- understand the process of experimental science: how science is done, the ways in which scientific discoveries are made every day.
- be able to interpret scientific discovery and their implications as presented in the reputable media.
- understand science as a way of knowing and how science (via the accumulation of new knowledge) changes our view of how the natural world works.

[1] taken from the Report of the Natural Science Core Subcommittee of the College's Core Curriculum Committee, Spring 1998)

Upon completion of the Natural Science Core Requirement, students should:

- have an understanding of the basic vocabulary of science, basic scientific concepts, and their application to the world known by the students.
- be able to use quantitative and mathematical skills in the interpretation of scientific data.
- be able to reason deductively based on observations and collection of data in its broadest sense.
- have an understanding of the process of scientific investigation, be able to view science as valid way of thinking about and studying the natural world, and understand how the analysis and interpretation of newly data can change the way we look at the natural world.
- be able to use acquired skills and knowledge to take advantage of scientific information resources available to the general informed public, and be an educated consumer of scientific, medical and technical services and information.
- know how to appropriately challenge and interpret information, and participate in informed debate.
- be prepared to make intelligent, defendable choices in the voting booth, especially in light of the complexities of scientific issues and their wider significance for our society and for our planet.

Course Offerings

- Students take 8 credits in one discipline (department) over two semesters; a weekly laboratory is an integral component of this requirement. In some cases the lab is included with the lecture in one course, in other cases the lab has a separate course number, but must be taken concurrently with the lecture.
- All of the courses listed in this booklet have been specifically designed for students who are majoring in subjects other than science. They all strive to adhere to the guidelines and goals of science core courses as described above.
- Students may seek to enhance their current major and career goals by choosing a course sequence that includes appropriate courses that they find particularly interesting. For instance, students who are pre-law might choose the Chemistry sequence so that they can take Criminalistics, or if they were interested in genetic counseling, they might choose the Biology sequence so that they can take Genetics and Human Affairs. There are lots of other ways in which to integrate these science courses into other majors, concentrations and intellectual interests.

AP CREDIT: Any student with appropriate scores on AP exams may be exempt from or may be placed out of Core Sciences courses regardless of their major. See the *Enchiridion* (and information in this booklet) for guidelines regarding AP credit.

PRE-MED, PRE-DENTAL REQUIREMENTS: **Students interested in admission to medical school, dental school, veterinary school, etc. and the allied health sciences must take the science courses required for majors in the sciences. These courses are not included in this booklet.** The courses that are listed in this booklet will NOT satisfy "pre-med" requirements. Liberal arts students interested in these professional tracks should make an

appointment to see the Health Sciences Advisor, Dr. John Friede (Biology, x97355) as soon as possible.

Core Courses in Astronomy

Students have two options for satisfying the science core requirement with courses in Astronomy:

- Planet Earth sequence: AST1050/AST1051 in the Fall AND AST1052/AST1053 in the Spring OR
- The Birth and Death of Stars (AST 1072/1073) in the Fall AND Planets (AST 1074/1075) in the Spring.

AST 1050/1051 and 1052/1053 - Planet Earth I and II (Lecture/Lab)

This two-semester sequence (lecture and lab) explores the Earth as our home and as a planetary member of the Solar System. It illustrates the human intellect confronting the physical manifestations of the laws of Nature. We will proceed in a developmental/ historical manner, exploring:

- the motions of the celestial objects and the motions of objects on the Earth
- the Copernican Revolution and Newton's Laws
- the motions of the Earth's crust and the structures of landforms
- the Earth's interior and atmosphere
- the nature of waves - sound and light
- the characteristics of matter and energy
- the lives of the stars and the creation of the elements.

The characteristics, dynamics, and evolution of the Earth and Solar System are investigated. This leads to the discovery and understanding of the fundamental scientific principles at work throughout the universe. Throughout, we will employ the scientific method - exploring new phenomena and seeking their underlying components. It is the goal of this course that every student will be able to use the scientific method in the critical examination of life on Planet Earth.

Labs will use both observational and experimental approaches to the scientific method. Experimental labs consist of the acquisition and analysis of data taken through direct experimental interaction (e.g., the analysis of the motion of freely falling objects). Observational labs consist of the acquisition and analysis of data taken from objects or phenomena which cannot be examined by experimentation (e.g., the motion of the Moon and planets). Both approaches, separate in process yet complementary in nature, reveal the scientific principles at work in the evolution of Planet Earth.

AST 1072/1073 - The Birth & Death of Stars (Fall, lecture/lab)

From a clear and dark site, thousands of stars can be seen with the unaided eye twinkling in the night sky. Stars appear to have a wide range of both brightness and color. Some are observed to vary in brightness and, occasionally new stars appear in the sky. What are those things? We will see how analysis of the light we receive from stars has revealed to us their fundamental nature. We will discuss the formation of stars, their basic properties, and how those properties evolve during a star's lifetime leading ultimately to a star's death and, sometimes, to the creation of an exotic new object such as a neutron star or a black hole. We will also examine our nearest stellar neighbor, the Sun, and see how its future evolution will affect the Solar System. Some specific goals for this course are:

- To learn some of what we now know about the stars. (e.g., we know what stars are, what they are made of, why they shine, how far away they are, how big they, how old they are, what their life spans are, how they form, and how they die!)
- To learn how we have come to understand so much about the stars. (Most of what we know about stars has come from studying that wee tiny bit of light you see shining in the nighttime sky. How is this possible?)
- To learn what role stars play in the evolution of the whole Universe.
- To see that our current understanding of stars and the Universe is based on repeatable observations, testable theories, and rigorous rules.

The lab will involve analysis of both real and simulated data from stars, using computers that will reveal their fundamental properties and the scientific basis of this knowledge.

AST 1074/1075 - Planets (Spring, lecture/lab)

The Solar System is our own local neighborhood in space, and consists of the Sun (a star) and the Sun's family, including the planets, their satellites (e.g., our Moon), the asteroids, and the comets. In this course we will explore the history and properties of this quiet little corner of the Universe. Some of our specific goals for this course will be:

- To understand how the Solar System came into existence.
- To discover the basic processes which shaped the surfaces and atmospheres of the planets, including the Earth, and see how those processes continue to operate in the Solar System today.
- To be able to compare and contrast the Earth with its fellow planets, and thus gain some insight into the uniqueness of our home world.
- To learn whether there might be other places in the Solar System besides the Earth which could harbor life.
- To learn how we have come to understand so much about the Solar System.

The lab will involve analysis of both real and simulated data from planets, using computers that will reveal their fundamental properties and the scientific basis of this knowledge.

Core Courses in Biology

Students may satisfy their Core Science requirement by taking <u>either</u>:

- Biology 1505 + One Theme course <u>OR</u>
- Two Theme courses

All courses include a laboratory (one 3 hour lab per week) and have high school biology as a prerequisite. Biology 1505 is no longer a prerequisite for a Theme course (starting Fall 2005) and all students are welcome to take the Theme-Theme option.

<u>Suggestions</u>: Any student who has taken more than one year of HS Biology (e.g., Advanced Biology, AP Biology [regardless of test score] or any other biology course – e.g., Anatomy and/or Physiology, Environmental Science, etc.) is strongly advised to take the Theme-Theme option. Any student who feels that their high school preparation in biology was not particularly strong and would benefit from taking a college-level survey of modern biology prior to taking a Theme course, should take the Biology 1505 + Theme option.

AP Credit (see also *Enchiridion*): Liberal arts students who received a 4 or 5 on the AP Biology exam will receive 8 credits in biology and has thus satisfied the Core requirement in the Natural Sciences. Liberal arts students who received a 3 on the AP Biology exam and choose to satisfy their requirement by taking biology will place out of Biology 1505 and must take the Theme-Theme option.

BIO 1505 - Biology for Today (lecture and lab)
The course is a survey of modern biology that covers the biology of the cell, genetics, development and some aspects of molecular biology, whole organism physiology, organismal diversity, evolution and ecology. The laboratory portion of this course will use experimental approaches and methodologies employed by biologists in problem solving in the laboratory. Writing assignments on the interpretation of science presented in reputable popular media will be an important part of the course. The laboratory (one three hour lab per week) will include laboratory experiments demonstrating fundamental biological processes, an exploration of biological diversity, observations of living embryos in order to explore the dynamic process of animal development, and dissection of a fetal pig as a vehicle for active study of mammalian anatomy.

BIO 1605 - Heredity and Human Affairs (lecture and lab)
A brief history of genetics is included as are discussions of genetic engineering and assisted reproduction and their potential impact on our future. Topics to be considered include: mutation, chromosomal abnormalities, metabolic disorders and polygenic defects. Methods of identifying and treating human genetic problems are also considered. The interaction between genes and behavior as well as how genes actually cause phenotypic expression will also be discussed. Since human genetics plays so prominently in our future, a considerable amount of time will be devoted to discussing the social implications of genetic engineering, new reproductive techniques, the Human Genome Project, cloning, use of fetal tissue as a source of stem cells and other current and timely issues.

BIO 1625 - How Microbes Rule the World (lecture and lab)
This course will provide an overview of the field of microbiology and will cover the basic biology of bacteria, viruses. protozoans (single celled eukaryotes) and fungi, and explore the function of the human immune system. Topics will include prokaryotic and eukaryotic cell structure, microbial classification and biodiversity, control of microbial growth, how pathogenic microorganisms cause disease in humans and how the immune system fights off microbial invasion. Specific characteristics of some microorganisms that play important roles in our daily lives) will be examined. These include those involved in disease processes (e.g., HIV, smallpox, anthrax, *E. coli*, *Listeria*, *Staphlococcus, Streptococcus, Candid*a). In lab students will learn basic microbiological techniques, including bacteriological staining and bacterial identification tests (like those used in medical diagnostic labs) and will directly study a variety of common bacteria.

BIO 1655 - Human Physiology - Body Works (lecture and lab)
This course covers the principles and mechanisms that underlie how your body works. The (WebCT) course web site provides students with information and instructions, and extensive use

is made of e-mail for communication. It is necessary to have access to (but not ownership of) a computer, and no computer knowledge is required; if you can move a mouse and click, you'll be fine. Each lecture usually revolves around a web article, and the goal is to provide sufficient background to understand the meaning and ramifications of the article. This then permits students to engage in discussion and problem solving. In the laboratory, on-line simulations replace exercises that would usually involve dissection. In most labs, physiological recordings are made from whole animals (often using students as subjects), who feel no pain or discomfort. A distance learning version of this course is usually conducted over the summer. It is 100% web-based and all laboratory exercises have been replaced with web-based simulations. This version of the course gives students the flexibility to work around their schedules to complete exercises, tasks and exams within set deadlines.

BIO 1705 - Life in the Sea (lecture and lab) (Theme Course)

Over 70% of the earth's surface is covered by the oceans and most of the US population lives within several miles of the ocean. Thus, it is our responsibility to understand the processes that guide the geology, chemistry and biology of our coasts, the biodiversity of marine organisms, including our fisheries resources, so that we may conserve the world's oceans, which are significantly impacted by human activity. This first part of this course will explore the fundamentals of chemical, physical, and geological oceanography and their relationship to the evolution of marine organisms. We will discuss the biology and ecology of marine algae and seaweeds, invertebrates, fishes, marine birds and marine mammals and then the ecological processes that define marine habitats and communities (e.g., salt marshes, coral reefs and the deep sea). Topics for discussion may include: drugs from the sea, ecotourism and marine conservation, the economics of marine fisheries and other topics of current interest. A term paper will allow students to explore a relevant topic of their choosing. Different types of readings will provide insights into our knowledge of the oceans and the nature of our encounters with marine environments in both historical and contemporary contexts. One three-hour lab per week will include examination of a variety of marine organisms (including dissection of a dogfish shark and/or other fish), experiments dealing with biological processes unique to life in the sea, discussions/presentations of scientific papers from the primary literature, and will include a weekday or weekend field trip to Adventure Aquarium (Camden, NJ).

BIO 1785 - Plants and Civilization (lecture and lab)

Too often people regard plants as almost inanimate objects rather than dynamic organisms that play a critical and integral part in our daily lives; organisms that are just as active as we are, able to tell the seasons, determine the time of day, and respond to multiple other environmental stimuli. Plants are the earth's antennae that capture the sun's rays and make life on earth possible and have dramatically impacted human cultural development. This course is designed to allow students to gain a basic understanding of plant architecture and metabolism. In addition to basic plant structure, we will discuss topics such as farming the oceans, algae and water pollution, production of alcoholic beverages, the "green revolution", the origin of agriculture, and the diversity and uses of medicinal, psychoactive, and poisonous plants. In laboratory we will first consider basic plant structure and function. Then we will design physiological experiments exploring the effects of gravity, light direction, nutrition, and the influences of specific plant hormones. Early in the semester we will plant a garden in the greenhouse; hopefully to be consumed at the last lab. Some laboratories will be coupled with field trips such as fermentation

of wine and beer with a subsequent trip to a brewery and plant diversity followed by a guided tour of Longwood Gardens.

BIO 1885 – Special Topics - i.e., Animal Behavior (lecture and lab)
We all have a desire to understand the world around us that goes beyond what we need to know in order to survive; this curiosity is usually the main reason for our interest in animal behavior. Why do the cardinals on campus perch at the tops of trees and chirp so loudly? Why do earthworms emerge from the ground when it rains? Why do some killer whales hunt in packs and others hunt singly? Why do human parents work hard, potentially sacrificing pleasures for themselves, to support their children and send them to college? By observing animals, we can learn about their ecological relationships and their evolutionary history. Many animals can serve as model organisms for understanding the behavior of our own species, including nervous system and brain function, as well as the evolution of human behavior. Finally, those of us who wish to maintain and preserve the environment need to understand the behavioral processes of animals in the wild in order to conserve and protect them. Topics will include: how genes and the environment affect behavior, learning and animal consciousness, hormones and their role in aggression and reproduction, predator-prey interactions, visual and auditory communication, courtship and mate choice, and human social behavior. The course will include textbook readings, critical evaluation of scientific papers from journals, film clips, and discussions regarding current topics in animal behavior. The laboratory (one three hour lab per week) will teach behavioral research methods to help students develop skills in observational and experimental studies. In the second half of the semester, students will conduct group projects designed to provide a complete research experience including the formulation of hypotheses, the collection and analysis of data, and the written and oral presentation of the results.

Core Courses in Chemistry

Students wishing to satisfy their core requirement with courses in chemistry take CHM 1050/CHM 1001 (lecture/lab) in the fall semester and then choose from among a selection of theme courses (lecture and lab) offered in the spring semester.

Fall Semester

Students take a lecture course and its accompanying lab concurrently.

CHM 1050 - Chemical Themes Foundation (lecture)
An introduction to important principles in chemistry. This course provides the basis for a focused study in one of the special topics courses in the spring semester. Topics covered include (but are not limited to) units of measurement, the structure of atoms and molecules, inorganic nomenclature, bonding in inorganic and organic compounds, qualitative and quantitative aspects of chemical reactions, the properties of gases, properties of solutions, principles of chemical equilibrium, acid- base theories, and electrochemistry.

CHM 1001 - Experimental Chemistry I (taken concurrently with CHM 1050)
The laboratory emphasizes the scientific method with experiments involving simple syntheses and quantitative measurements, the analysis of materials (including many consumer products), and separations. Some experience with modern instrumentation will be provided to demonstrate the limitations accompanying the experimental method.

Spring Semester - Theme Courses

Students take a lecture course and its accompanying lab concurrently.

CHM 1057 - Criminalistics: An Introduction to Forensic Science (lecture)
Forensic science is the application of science to those criminal and civil laws that are enforced by police agencies in the criminal justice system. This course discusses the many areas of chemistry, biology, physics, and geology that are useful for determining the evidential value of crime-scene and related evidence. Topics such as the collection of physical evidence (glass, soil, hairs, fibers, ballistics, paints, fingerprints, and DNA) will be superimposed on discussions of law, forensic toxicology/serology, arson and explosion investigations and document/voice examinations. Case studies will be used whenever possible to supplement text (and laboratory) materials. Guest lecturers from law enforcement agencies, regional crime laboratories, and local medical facilities will contribute their unique perspectives on current events.

CHM 1007 - Criminalistics Laboratory (taken concurrently with CHM 1057)
This laboratory course will provide a "hands-on" look on how forensic analyses are performed. Physical evidence will be examined using a variety of forensic techniques, including chemical testing (for blood, body fluids, etc.), physical and microscopic analysis (of hair samples, fibers, etc.), and DNA analyses. The chemical nature of accelerants for arson cases will be studied, as well as fingerprint, footprint, and document examinations.

CHM 1058 – Chemistry and Art (lecture)
The comprehensive study of archeological or historical finding and works of art are essential components of our history and cultural heritage, often require an in-depth knowledge of various physical and chemical analysis techniques. This course discusses the many areas of chemistry, physics and geology that are useful for understanding the origin, preservation and authenticity in the fine arts. Topics will include light and color, pigments and dyes, photography, ceramics and other artistic media. Case studies will be used whenever possible.

CHM 1008 – Chemistry and Art Laboratory (taken concurrently with CHM 1058)
This laboratory course will provide a "hands-on" experience of how artistic materials are created and analyzed. Experiments will include pigment synthesis, photographic chemistry, electroplating and the production of glasses, glazes and ceramics.

Core Courses in Geography and The Environment

Geography and The Environment I and II are a two-semester sequence that is designed primarily for students in the Geography and The Environment Studies Concentration for whom both courses are required. These courses provide students with a foundation in environmental science as a basis for further interdisciplinary study in the program. Although preference is given to students in the Concentration, other interested and motivated students are welcome in the courses. Environmental Science I is a prerequisite for Environmental Science II.

For more information about the Geography and The Environment Studies Concentration, please refer to the website (www.villanova.edu/artsci/geoenv/) or contact the Director, Dr. Frank Galgano (610-519-3337; frank.galgano@villanova.edu).

Fall and Spring Semester (2 Semester Sequence)

GEV 1050 - Environmental Science I & GEV 1051 - Environmental Science II (lecture and lab, both semesters)

Two-semester course sequence providing a multidisciplinary foundation in Environmental Science. Lectures and accompanying laboratories include instruction in:

- environmental biology, including ecology, conservation biology and biodiversity, wildlife biology, and population biology
- earth science and natural resources
- energy, including fossil, nuclear, and renewable sources
- environmental chemistry, pollution, and toxicology
- environmental and human health
- sustainability science, including some aspects of environmental engineering and environmental economics

Laboratories emphasize techniques and approaches scientists use to investigate environmental problems, and include collection and statistical analysis of quantitative data from experimental and observational study in lab and field.

Core Courses in Physics

Students wishing to satisfy their Core Science requirement by taking courses in Physics take the two semester sequence "Great Ideas in Physics".

PHY 1020/1021 <u>and</u> 1022/1023 - Great Ideas in Physics (lecture/lab)
This two semester sequence, is designed to introduce non–science majors to the wonders of physics through:

- a study of the history of physical science
- a demonstration of the workings of classical physics in our everyday lives,
- an introduction to some of the more modern ideas of physics that students may have heard about in the press or on television.

The lectures in the first semester cover such topics as the history of science and physics, describing motion (kinematics), explaining motion through Newton's laws (dynamics), specific applications of Newton's laws (circular motion, buoyancy, equilibrium, etc.), and the laws of Conservation of Energy, Momentum, and Angular Momentum. The second semester covers thermodynamics with an emphasis on its applications to earth science and meteorology, optics, electricity, magnetism, and if time permits, relativity and "modern" physics. In both semesters, rather than emphasizing a numerical problem–solving approach, an understanding of the underlying concepts will be emphasized. Students are expected to be able to solve some simple algebraic problems during the course of the year. In both semesters, the lab courses stress both a qualitative analysis of data (what happened during this experiment?) and a parallel quantitative analysis (the mathematical relationships among the data are . . .). Computers are used extensively in the lab to analyze data. Additionally, topics are covered in lab that are not covered in detail in lecture, i.e., radioactivity, absorption of light, and simple vibrations (springs and pendulum).