

# BIOLOGICAL AND ENVIRONMENTAL SCIENCES

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## Biological Sciences

The Department of Biological and Environmental Sciences offers B.A. and B.S. degree programs in biological sciences and B.S. degrees in environmental science systems and environmental studies. Students interested in graduate study in biology; in medical, dental or veterinary training; or in forensics should choose one of the B.S. programs in biological sciences with two or more years of chemistry. Those interested in a B.A. in Biological Sciences may elect a broad range of courses in the humanities or social sciences in place of the advanced chemistry or physics normally taken with the B.S. program. Students interested in environmental science should consider the multidisciplinary or systems approach to global environmental problems offered through the B.S. in Environmental Science Systems. Students interested in social, economic or policy aspects of the environment should consider the interdisciplinary major in environmental studies (see Interdisciplinary Programs (<http://collegecatalog.lemoyne.edu/interdisciplinary-programs/environmental-studies>) section of this catalog). In addition, minors in biological sciences, environmental science systems and environmental studies are available. Students interested in a major in biochemistry, can find it in the Interdisciplinary Programs (<http://collegecatalog.lemoyne.edu/interdisciplinary-programs/biochemistry>) section of the catalog.

The B.S. program in biological sciences also offers three optional concentrations in health professions, molecular biology and neurobiology. The B.A. program offers an optional concentration in biological education for students interested in teaching biological content to K-12 students.

In addition to the above, a five-year program leading to a B.S. degree in biological sciences and an M.S. in physician assistant studies is available to successful applicants. Through an articulation with Syracuse University's College of Engineering, students can also pursue a five-year program leading to either a B.A. in Biological Sciences and M.S. Bioengineering or a B.S. in Environmental Science Systems and M.S. in Environmental Engineering Science (see Undergraduate Transfer Programs (<http://collegecatalog.lemoyne.edu/arts-sciences/>

[undergraduate-transfer-programs/#programstext](http://collegecatalog.lemoyne.edu/arts-sciences/undergraduate-transfer-programs/#programstext)). Students interested in this option should choose one of the pre-engineering concentrations. An additional articulation with Syracuse University allows qualified students to apply for a five-year program leading to a B.S. in biological sciences and an M.S. in forensic science or biomedical forensic sciences. For more information see the Undergraduate Transfer Programs (<http://collegecatalog.lemoyne.edu/arts-sciences/undergraduate-transfer-programs/#programstext>) section of this catalog.

All students are encouraged to conduct research with faculty members.

College policy requires students to achieve a minimum GPA of 2.0 in their major in order to graduate. To help ensure that students can graduate on time, the department of biological and environmental sciences policy states that if students have not achieved a major (biological sciences or environmental sciences) GPA of at least 2.0 after taking 12 credits of Le Moyne BIO or ESS courses (3 lab courses), they will have one semester to raise their GPA to above 2.0. If a student does not achieve a minimum of 2.0 in the major at the end of that semester, he or she will need to petition the department in order to remain a biological sciences major.

## Environmental Science Systems

The Environmental Science Systems major emphasizes a multidisciplinary or systems approach to scientific and environmental problems. The primary goal of the major is to train majors in a systems approach to scientific problems in general and problems of global change in particular. By exposing students to the problems of understanding, measuring, and predicting the consequences of global change, and by providing them with field-based research experiences at an early point in their academic careers, we hope to stimulate an interest in these young scientists in pursuing research-oriented career paths. Students interested in learning about the Bachelor of Science in Environmental Studies should visit the page on Interdisciplinary Programs (<http://collegecatalog.lemoyne.edu/interdisciplinary-programs/environmental-studies>).

## Student Learning Outcomes in Biology

Students who graduate from this program will be able to:

Disciplinary knowledge

Demonstrate disciplinary knowledge at the different levels of biological organization.

Search Scientific Literature

Search and evaluate the scientific literature in order to identify acceptable sources.

Analyze and Interpret the Scientific Literature

Critically read the scientific literature in order to evaluate the scientific process.

Communicate

Effectively communicate scientific information.

Scientific process

Apply the scientific process through observation, experimentation, and hypothesis testing.

Human activities

Articulate the biological consequences associated with human activities.

## Student Learning Outcomes in Environmental Science Systems

Students who graduate from this program will be able to:

### Physical environment

Demonstrate an understanding of how Earth's biological communities (ecological systems) are controlled by the physical environment.

### Diversity

Demonstrate knowledge of the diversity of biological communities and their evolution and distribution on Earth.

### Scientific process

Apply the scientific process to the study of environmental problems through the design and execution of research.

### Origin and exploitation

Demonstrate an understanding of the origin of natural resources and the environmental and societal consequences of their exploitation.

- Biological Sciences Major (B.S.) (<http://collegecatalog.lemoyne.edu/arts-sciences/biological-sciences/biological-sciences-bs>)
- Biological Sciences Major (B.A.) (<http://collegecatalog.lemoyne.edu/arts-sciences/biological-sciences/biological-sciences-ba>)
  - B.A. in Biology with a Concentration in Pre-Engineering (<http://collegecatalog.lemoyne.edu/arts-sciences/biological-sciences/biological-sciences-ba>)
- Biology Minor (<http://collegecatalog.lemoyne.edu/arts-sciences/biological-sciences/biology-minor>)
- Environmental Science Systems Major (B.S.) (<http://collegecatalog.lemoyne.edu/arts-sciences/biological-sciences/environmental-science-systems-bs>)
  - Environmental Science Systems (B.S.) with a Concentration in Pre-Engineering (<http://collegecatalog.lemoyne.edu/arts-sciences/biological-sciences/environmental-science-systems-bs-environmental-engineering-ms>)
- Environmental Science Systems Minor (<http://collegecatalog.lemoyne.edu/arts-sciences/biological-sciences/environmental-science-systems-minor>)
- Environmental Studies Major (B.S.) (<http://collegecatalog.lemoyne.edu/interdisciplinary-programs/environmental-studies/environmental-studies-bs>)
- Environmental Studies Minor (<http://collegecatalog.lemoyne.edu/interdisciplinary-programs/environmental-studies/environmental-studies-minor>)

## Biology (BIO)

### BIO 191. General Biology I. 4 Credit Hours.

This course introduces fundamental unifying principles of biology. Topics include the scientific method, biological chemistry, cell structure and function, membranes, energetics, cellular regulation and control, genetics, cell division and evolution. Three hours lecture and three hours laboratory per week. Carries biology major credit.

### BIO 192. General Biology II. 4 Credit Hours.

This course, while continuing to stress fundamental unifying principles of biology, presents the mechanisms that allow all living organisms to meet the common requirements for life. Topics include classification/diversity; basic characteristics of all kingdoms of life; plant and animal development, form and physiology; ecology and population biology. Three hours lecture and three hours laboratory per week. Dissection required. Carries biology major credit.

Prerequisite: BIO 191 or permission.

### BIO 218. Cell and Molecular Biology. 4 Credit Hours.

This course is designed to introduce the student to cell biology and the concepts of genetics at the molecular level. Basic concepts of cell structure and function are presented from a biochemical perspective. Topics include metabolism, membranes, cytoskeleton, motility, and replication and expression of genetic information. Three hours lecture and three and a half hours laboratory per week. Carries biology major credit.

Prerequisites: BIO 191-192; CHM 151-152 recommended.

### BIO 225. The Poisoning of a Planet. 3 Credit Hours.

The pollution of our air, land, and water is an ecological problem of epidemic proportions. However, before we can come to grips with this menace, we must understand what we are facing. Our present situation results from economic conflicts, social attitudes, political indecision and the overuse and misuse of scientific and technological ideas. In this course, we will examine environmental issues such as resource depletion, pollution, overpopulation, and the nuclear winter. We will begin with the biological and ecological basis of these problems and then, in a multidisciplinary fashion, address the possible solutions and consequences of these issues. Carries biology major credit.

Prerequisites: BIO 191-192.

### BIO 230. General Ecology. 4 Credit Hours.

This course uses an evolutionary approach to the study of the interrelationships of organisms with their environments. Topics include competition, co-evolution, population growth and regulation, demography, and predator-prey relationships. Laboratory work includes field study and basic methods for evaluation of data. Three hours lecture and three hours laboratory per week. Carries biology major credit.

Prerequisites: BIO 191-192.

### BIO 237. Ecology of the Galapagos. 3 Credit Hours.

This course allows students to study, in both classroom and field settings, the delicate balance between geological, biological, climatologic and anthropogenic processes in shaping ecological environments, with specific focus on the biogeography of tropical islands. The Galapagos Archipelago is a singular locale where the fragile nature of the environment, the processes that shape it, and the unique nature of its inhabitants are readily observed. Additionally, the historic significance of this locale in the development of one of the foundational theories of modern science will be explored fully. Additional expense for required travel component.

Prerequisite: BIO 191 and BIO 192.

Cross-listed Courses: ESS 237

**BIO 245. Evolution. 4 Credit Hours.**

The nature of the evolutionary process is studied from a number of relevant points of view, including geology, paleontology, comparative anatomy, genetics, molecular biology and anthropology. The significant influence of evolutionary concepts on human thought is discussed. Three hours lecture and three hours laboratory per week. Carries biology major credit.

Prerequisites: BIO 191-192.

**BIO 265. Intro to Geographic Info Systems. 3 Credit Hours.**

This course is designed to introduce students to Geographic Information Systems (GIS), a set of hardware, software, and methods for the capture, storage, management, manipulation, analysis, modeling, and display of geographic information. This course will provide an introduction to GIS applications and analysis. Course work will emphasize use of industry standard software. Two hours lecture, two hours lab per week. Carries BIO and ESS major credit.

Cross-listed Courses: ESS 265

**BIO 270. Animal Behavior. 4 Credit Hours.**

The mechanisms of animal and human behavior are investigated in a broad descriptive sample. Special emphasis is placed on the physiology, development and evolution of behavior patterns. Three hours lecture and three hours laboratory per week. Carries biology major credit.

Prerequisite: BIO 191, BIO 192 AND CHM 152.

Cross-listed Courses: PSY 303

**BIO 281. Anatomy and Physiology I. 4 Credit Hours.**

Biology majors will study mammalian anatomy and physiology at a level appropriate for those interested in attending graduate programs in the health professions. This course is the first in a two-semester sequence. Following an overview of terminology and tissues, the skeletal, muscular, nervous, endocrine and integumentary systems will be covered. The cat is the primary dissection specimen in the laboratory; lab activities will integrate anatomy and physiology. Dissection required. Pre-requisites: BIO 191 and 192, CHM 151 and 152. Three hours of lecture and three hours of laboratory per week. Carries biology major credit. Students may take either BIO 431 or BIO 281-282, but not both. Depending on the course instructor, the class format may be primarily traditional lectures OR may incorporate the significant use of a Learning Management System, e-lectures, case studies, and discussion. Students should consult the department chair regarding the lecture format prior to registering for this course.

**BIO 282. Anatomy and Physiology II. 4 Credit Hours.**

This course is a continuation of BIO 281 in which biology majors will continue their study of mammalian anatomy and physiology. Systems covered include the circulatory, immune, respiratory, digestive, urinary, and reproductive. The cat is the primary dissection specimen in the laboratory; lab activities will integrate anatomy and physiology. Dissection required. Three hours of lecture and three hours of laboratory per week. Carries biology major credit. Students may take either BIO 431 or BIO 281-282, but not both.

Prerequisites: BIO 191 and 192, CHM 151 and 152, and a grade of C or better in BIO 281.

**BIO 310. Field Ornithology. 4 Credit Hours.**

This course will cover basic bird physiology, ecology, and conservation biology with a strong emphasis on field ecology. Students will be required to actively engage in bird identification, behavioral observation, and field data collection. This course will provide students with an extensive field experience aimed at broadening their view of the biological world around them. A major component to this course will be a Spring Break experience in southern Texas. Attaining experience in different ecoregions supplies students with a valuable perspective for thinking more broadly about biology. Additional expenses-travel expenses round-trip to McAllen, TX. Students must meet with the instructor before registration. Prerequisite(s): BIO 191 BIO 192.

Cross-listed Courses: ESS 310

**BIO 315. Biology in Practice:Lab & Field Approac. 3 Credit Hours.**

Aimed at providing students, especially those who are planning to teach, with additional laboratory field experience, this course explores empirical techniques currently used in a variety of biological subdisciplines. Formulation and testing of hypothesis, experimental design, data analysis and interpretation of results will be addressed. Students will have the opportunity to get hands-on experience with various techniques as well as methods analysis. A major objective of the course is the development of exercises utilizing these techniques to foster inquiry-based learning in biology. Writing techniques appropriate to the discipline will also be an important component.

Prerequisites: BIO 191, BIO 192, BIO 218.

**BIO 320. Genetics. 4 Credit Hours.**

This course will teach students the fundamental concepts underlying the field of genetics and introduce them to the increasing role that genetics plays in society. Lectures and labs will cover principles of both classical and molecular genetics. Topics covered include inheritance, gene expression, population genetics, and biotechnology. Three hours lecture and three hours laboratory weekly. Carries biology major credit. Prerequisite: BIO 218.

**BIO 321. Developmental Biology. 4 Credit Hours.**

This course will study embryogenesis (fertilization to birth) as well as development during later stages of life. We will examine the cellular, genetic, and molecular aspects of these processes in a number of different species. This information will be supplemented with the experimental data that led to these discoveries. The laboratory portion of this course will involve students designing and carrying out their own experiments. Three hours lecture and three hours laboratory per week. Carries biology major credit.

Prerequisite: BIO 218.

**BIO 322. Histology. 4 Credit Hours.**

Following a consideration of fundamental tissues, most of the organ systems of the mammalian body are studied showing how these systems are actually combinations of the basic tissues. Three hours lecture and three hours laboratory per week. Carries biology major credit.

Prerequisites: BIO 191, BIO 192, BIO 218.

**BIO 325. Microbiology. 4 Credit Hours.**

This course emphasizes bacteria, but also deals with other groups of organisms recognized as microbes. Topics include the structure, physiology, differentiation and genetics of microorganisms, as well as ecological, industrial and disease relationships. CHM 223 and CHM 224 recommended. Three hours lecture and four hours laboratory per week. Carries biology major credit.

Prerequisites: BIO 191 BIO 192, BIO 218.

**BIO 327. Botany - The Biology of Plants. 4 Credit Hours.**

The activities of plants support life on earth. An understanding of the biology of plants influences the welfare of humans and other animals. This course explores the diversity and basic biology of plants. Topics include classification, physiology, morphology, evolution, and life cycles. Prerequisites or corequisites: BIO 191-192, CHM 151-152. Three hours lecture and three hours laboratory per week. Carries biology major credit.

**BIO 330. Tropical Marine Biology. 4 Credit Hours.**

Tropical ecology differs in many respects from that of temperate regions. The most striking of these differences occurs in the marine environment. Semester activities will include weekly meetings in which we will examine the flora, fauna and processes that characterize tropical marine systems. The course will end with 10-14 days of intensive field work in the Bahamas, studying the principles discussed in class with special attention to field and lab work as well as an individual research project. Separate fees will be required for the field portion of the course. Carries biology major credit.

Prerequisite: BIO 191 BIO 192 and permission of the instructor.

**BIO 335. Biodiversity. 3 Credit Hours.**

The course is designed to acquaint the student with the phenomenal diversity of life with which we share this planet. To do this, we will refresh the students' memories concerning evolution and the various mechanisms through which communities of life forms have become adapted to their environment. We will spend some time with taxonomy and biogeography before we can begin to examine the current state of biodiversity as well as future trends. The implications of these trends will signal a stopping point for the course but will hopefully serve as a beginning for the student as they move away from Le Moyne and take a place in society.

Prerequisites: Minimum of 10 BIO/ESS credits.

Cross-listed Courses: ESS 335

**BIO 340. Parasitology. 4 Credit Hours.**

Parasitism is the most prevalent and one of the most biologically complex of all symbiotic relationships. Parasites historically have had and continue to have a tremendous impact on the health and welfare of humans and other animals. This course explores the diversity of parasitic organisms and the adaptations which permit them to live in or on other organisms, as well as consequences to the host. Prerequisites or corequisites: BIO 191-192 and one 200-level course. Three hours lecture and three hours laboratory per week. Carries biology major credit.

**BIO 348. Environ Research in the Field: Iceland. 4 Credit Hours.**

The environment of Iceland is shaped by the immensely dynamic geologic processes of active volcanoes and glaciers, but this environment is also deceptively fragile and subject to anthropogenic influence. The present landscape has resulted from this interaction of human and natural processes. A semester of classroom activity culminates in a field session where students conduct research on the processes of environmental change in Iceland.

Cross-listed Courses: ESS 348

**BIO 350. Invertebrate Biology. 4 Credit Hours.**

This course introduces the study of invertebrate animals; classification, structure and life cycles are presented in detail. Three hours lecture and three hours laboratory per week. Carries biology major credit.

Prerequisites: BIO 191-192.

**BIO 360. Insect Ecology. 4 Credit Hours.**

Insects outnumber all other species on this planet, and they have crucial roles in ecosystem structure and processes. This course explores the diversity of interactions between insects and other organisms in ecosystems, as well as insects' impact on the non-living environment. Three hours lecture and three hours laboratory per week. Carries biology major credit.

Prerequisites: BIO 191, 192, BIO 225.

**BIO 365. Criminalistics for Biologists. 3 Credit Hours.**

This course will allow upper level biology majors to discover how information they have learned in their natural and physical science courses is utilized in criminalistics. In addition to lectures, students will participate in a number of hands on mini-laboratory sessions that will allow them to perform techniques used in the collection of evidence from a crime scene, as well as laboratory analyses of this evidence. Carries biology major credit.

Prerequisites: BIO 218 and CHM 151-152; recommended courses include completion of BIO 281-282 and two semesters of physics.

**BIO 375. Introduction to Neurobiology. 4 Credit Hours.**

The uniqueness of the central nervous system is explored in lectures and laboratory sessions dealing with the developmental, anatomical, and physiological aspects of neurobiology. This course is intended for biology and psychology majors and may be taken by others who are minoring in biology. Three lectures and three hours laboratory per week. Prerequisites and corequisites: BIO 191-192, BIO 218; CHM 223 is recommended, or by permission of instructor.

**BIO 380. Information in the Biological Sciences. 1 Credit Hour.**

This course will introduce the changing information landscape in the biological sciences, and help students become advanced database and "free web" searchers. Students will also become familiar with the social and ethical issues relating to the production and use of scientific information in an increasingly digital society. Prerequisite(s): BIO 191, BIO 192, and BIO 218 or permission of instructor.

Cross-listed Courses: LIB 380

**BIO 381. Disease and Disorders of the Nervous System. 3 Credit Hours.**

This course will examine several diseases and disorders of the nervous system. Symptoms, diagnoses, and prognoses of numerous pathologies will be investigated along with in-depth discussions of the anatomical and physiological changes that occur relative to the healthy nervous system. A particular emphasis will be placed on cellular and molecular changes. Students will supplement lecture material with primary literature searches investigating ongoing research including current and future strategies to treat and detect the disorders. Case studies will also be utilized to demonstrate how dysfunction can manifest in the patient, subsequently reinforcing our understanding of how the nervous system performs.

Prerequisites: BIO 218; also BIO 281-282 or BIO 375 or permission of the instructor.

**BIO 390. Independent Study in Bio & Natural Syst. 1-3 Credit Hours.**

A student may pursue a semester or more of independent study in a specialized area of biology of mutual interest to the student and one or more members of the faculty in the department. This course is for the above average student whose interests and abilities go farther than normal course offerings. Proposals, indicating credit sought, must have approval prior to registration. Prerequisites or corequisites: 15 credit hours in BIO in addition to BIO 380. Carries biology major credit for the tenth biology course.

Cross-listed Courses: ESS 390

**BIO 409. Virology. 3 Credit Hours.**

This course will explore fundamental aspects of viral biology including viral replication strategies, structural attributes, virus evolution and tactics used by viruses to evade host immune responses. Several currently relevant viruses will be discussed in detail to explore how molecular features of viruses impact human disease. In addition, we will discuss the broader applications of virology with particular emphasis on viruses and cancer, the use of viruses in vaccine approaches and gene therapy, targeting bacterial infections with bacteriophage and newly emerging viruses. In addition to lecture material, students will critically read and discuss primary virological literature.

Prerequisite: BIO 218.

**BIO 410. Toxicology. 3 Credit Hours.**

This course is designed to be of interest to students of environmental biology as well as those planning for a career in the health professions. General principles and mechanisms of toxicology, effects of exposure to different types of toxins, and various applications of toxicology will be discussed. Prerequisites or corequisites: BIO 191, 192, 218; CHM 223, 224. Three hours of lecture per week. Carries Biology major credit.

**BIO 412. Immunology. 3 Credit Hours.**

This course will offer students the opportunity to study the function of one of the human body's most intricate, and somewhat underappreciated systems. Students will examine how the human immune system is capable of producing a coordinated response to combat infectious organisms as well as what can happen when the immune system functions improperly. Coupled with establishing a base of immunology fundamentals will be the opportunity for the students to apply the knowledge acquired from text readings and from lecture. Through the individual and group discussion of primary scientific literature throughout the semester the student will be able to develop critical thinking and analytical skills. Three hours of lecture per week. BIO 281 and 282 are recommended.

Prerequisite: BIO 218.

**BIO 415. Pathogenic Microbiology. 4 Credit Hours.**

The interaction between a pathogen and its host has two potential outcomes, resistance or disease. Pathogenic microbiology, therefore, is a discipline that demands an understanding of the microorganisms that cause disease, the human immune system and the mechanistic interplay between the two. This course aims to provide foundational knowledge in the area of host-pathogen interactions. Following an introduction to the microbes that naturally colonize humans, students will learn the molecular mechanisms used by microbial pathogens to overcome host barriers to infection. We will then begin a survey of clinically relevant microbial pathogens, including those that have the potential to be used as bioterror agents. We will end the semester with an in-depth examination of methods to detect infectious agents and therapeutics to limit disease. Three hours lecture and three hours laboratory per week. Carries biology major credit.

Prerequisites: BIO 218 and BIO 325.

**BIO 418. Advanced Molecular Biology. 4 Credit Hours.**

This is an advanced, lab-intensive course focusing on the application and development of molecular genetic data. Lectures will focus on the practical applications of molecular data to address ecological, evolutionary, and medical questions. Lectures will also provide students with the theoretical background necessary to understand current molecular analytical and lab techniques. Labs will provide students with hands-on experience generating and analyzing molecular genetic data. Two hours lecture and six hours laboratory per week. prerequisites or corequisites: BIO 218; CHM 223-224 and at least junior standing.

**BIO 420. Special Topic: Field Botany. 4 Credit Hours.**

The four-credit course will survey the flora of central New York, with excursions to various habitats including grasslands, sand dunes, peat bogs, old-growth forests, and wetlands. Plant identification and systematics will be the major focus, and students will learn how to create and curate an herbarium, compare the species composition of the various habitats, and learn human impacts and the importance of conservation of natural habitats and native species. The six hour block allows for travel and time in the field.

Prerequisites: BIO 191 and BIO 192.

Cross-listed Courses: ESS 420

**BIO 421. Special Topic: Research in Tropical Biology. 4 Credit Hours.**

A variety of ecosystems exist throughout the tropics and are home to the majority of the terrestrial biodiversity found around the globe. Studies of organismal interactions and species diversity are still leading to the creation of new scientific knowledge and discovery of new species, and Costa Rica represents a county with diverse tropical forests that form the basis for many of these discoveries. This upper-level field-experience course will allow students to search, analyze and interpret the scientific literature during classroom activities at Le Moyne College, then apply the scientific process through observation, experimentation, and hypothesis testing during a three-week session in Costa Rica. Additional fees will be required for this course. Carries BIO and ESS major credit.

Prerequisites: BIO 191 and BIO 192 and junior or senior standing in the Biological sciences, Biochemistry, or Environmental Science Systems, and permission of the instructors.

Cross-listed Courses: ESS 421

**BIO 421L. Research in Tropical Biology Lab. 0 Credit Hour.****BIO 427. Bioinformatics. 4 Credit Hours.**

Bioinformatics is the use of computer technology to store and analyze large genetic and genomic datasets. The availability of these datasets and increasing computational abilities have led to a "bioinformatics revolution" in biology with applications in many biological disciplines, including molecular ecology and health care. In this course, students will learn the theory behind the major concepts of bioinformatics and apply this knowledge analyzing biological datasets in computer labs. Topics covered may include searching sequence databases, sequence alignment, sequence motif discovery, phylogenetic analyses, analysis of protein and nucleic acid structure and genome mapping. Three hours lecture and three hours computer laboratory per week. Carries biology major credit.

Prerequisites: BIO 218.

**BIO 431. Mammalian Physiology. 3 Credit Hours.**

This course is designed to teach basic principles of mammalian physiology involving the following systems: nervous, endocrine, muscular, circulatory, excretory, digestive, immune and reproductive. CHM 223-224 recommended. Carries biology major credit. Students may take either BIO 431 or BIO 281-282, but not both.

Prerequisites: BIO 191-192, BIO 218.

**BIO 450. Biology of Sharks. 3 Credit Hours.**

Few organisms fascinate humans as much as sharks and their relatives, the skates, rays and chimaeras (class Chondrichthyes). Despite this, many people lack an understanding of these fishes and their beliefs and opinions are biased by misperceptions that permeate society. This course provides a detailed overview of the biology of sharks, including morphology, physiology, ecology, behavior, and genetics. Special emphasis will also be placed on the evolution and diversity of sharks and shark-human interactions, including shark fisheries.

Prerequisites: BIO 218 and BIO 225.

**BIO 458. Global Climate Systems. 3 Credit Hours.**

In this class, students will come to recognize that Earth's biosphere, atmosphere, hydrosphere, and geosphere operate in complexly linked systems in which various components are exchanged over greatly varying time scales. Using laboratory and field studies, students will measure, discuss and define the impact of global change on natural systems.

Prerequisites: CHM 151 and CHM 152 and a minimum of 15 credits of BIO, including at least one course in the Ecology/Population Biology Area.

Cross-listed Courses: ESS 458

**BIO 460. Biochemistry I. 3 Credit Hours.**

A lecture course in the chemistry of physiologically relevant compounds. These include proteins, nucleic acids, carbohydrates and lipids. The interactions, regulation and metabolism of these compounds will be introduced. Three hours of lecture per week. Carries biology major credit.

Prerequisites: CHM 224 and BIO 191 or permission of instructor.

Cross-listed Courses: CHM 460

**BIO 461. Biochemistry II. 3 Credit Hours.**

This course is a continuation of BIO 460. Topics to be covered include cellular metabolism and energy production; synthesis and degradation of lipids, amino acids, nucleotides; and regulation of gene expression.

Carries biology major credit.

Prerequisite: BIO 460.

Cross-listed Courses: CHM 461

**BIO 462. Biochemistry Laboratory. 1 Credit Hour.**

This laboratory will introduce techniques for studying proteins, nucleic acids and lipids. Prerequisite or corequisite: BIO 460. Carries biology major credit.

Prerequisites: CHM 224 and BIO 191, or permission of instructor.

Cross-listed Courses: CHM 462

**BIO 470. Seminar: Environmental Topics. 3 Credit Hours.**

This advanced seminar provides students with the opportunity to explore the complexity of environmental issues in detail. By choosing current topics and analyzing the scientific and socio-economic factors underlying environmental problems, students will develop greater awareness and understanding of society's ability to mitigate these problems. This course places a high emphasis on oral and written presentation skills.

Prerequisite(s): 20 credits in BIO, ESS, PSC, ECO from 200, 300 or 400 level courses.

Cross-listed Courses: PSC 470, ESS 470

**BIO 471. Perspectives on Human Life. 3 Credit Hours.**

The meaning and implications of biological evolution, genetic engineering and population growth are considered in this course, with special reference to the consequences of the issues on human life. Three hours lecture/week. Carries biology major credit.

Prerequisites: BIO 191-192.

**BIO 475. Stem Cell Biology. 3 Credit Hours.**

This course will examine the relatively new and expanding field of Stem Cell Biology. Students will dissect and analyze the most current primary literature from this exciting new field along with examining the basic science of molecular biology, fate determination, cell proliferation and differentiation. We will analyze the biology and ethics involved in this rapidly growing field and discuss the direction this field might and perhaps should go in. Throughout this course we will discuss how this field of study may impact our lives along with the potential benefits and dangers of this pursuit.

Prerequisite: BIO 218.

**BIO 480. Seminar: Biology of Cancer. 3 Credit Hours.**

This seminar will offer advanced students the opportunity to further develop research and presentation skills required in graduate or medical school. Cancer biology is an area of intense research in fields ranging from toxicology and environmental biology to molecular biology. This seminar will examine the cell and molecular basis of cancer as a means to improve students' ability to critically evaluate the scientific literature. Students will select papers from the scientific literature for analysis and presentation in both written and oral formats. Students may be required to attend a scientific lecture off campus during the semester.

Prerequisites or corequisites: BIO 218 and junior or senior standing in biological sciences or biochemistry or permission of the instructor. Three hours of lecture per week. Carries biology major credit.

**BIO 481. Seminar: Endocrine Disruptors. 3 Credit Hours.**

This seminar will offer upper level students in the sciences the opportunity to develop or enhance research and presentation skills required in graduate or professional school. Improper use and disposal of chemicals and physical agents by humans have caused a number of adverse effects in all living things. This seminar will specifically focus on environmental contaminants that have been shown to alter the function of the endocrine system in wildlife and humans. Although this course will utilize textbooks, it will rely heavily on the scientific literature for additional readings and assignments. Students may be required to attend one scientific lecture off campus during the semester.

Prerequisites or corequisites: BIO 218, junior or senior standing in biological sciences or biochemistry or permission of the instructor. Carries biology major credit.

**BIO 482. Seminar: Current Issues in Genetics. 3 Credit Hours.**

This seminar will offer advanced students the opportunity to further develop skills of critically analyzing primary literature in the field of genetics and presenting those literature critiques. Genetics is at the foundation of all areas of biology. This seminar will examine both forward and reverse genetic approaches, mapping genes and creating gene knockouts to understand gene function and the implications to these broader areas of study. Students will select papers from the scientific literature for analysis and presentation in both written and oral formats. Students may be required to attend a scientific lecture off campus during the semester. Three hours of lecture per week. Carries biology major credit. Prerequisite(s): BIO 218 and permission of the instructor, BIO 320 is strongly recommended.

**BIO 490. Internship in Biology. 1-3 Credit Hours.**

The goal of this class is participation in a field-learning experience closely related to the student's major field of study. The student intern will meet regularly with his or her supervisor in the agency and will report as required to the faculty member assigned to supervise the internship. Students are expected to apply what they have learned in the academic program to the internship. An evaluation of the experience will also be required. The internship and placement must be approved by the faculty coordinator. Three hours of field work per week are required to generate one credit hour. Therefore, a three-credit internship will require at least nine hours on site per week. The number of credit hours to be awarded must be determined and contracted prior to registration. A signed Memorandum of Understanding (MOU) with the placement site must be on file with the Office of Career Services prior to the start of the internship experience.

Prerequisite: 64 credit hours of coursework in the major program or permission of the department chair.

**BIO 499. Research in Bio & Environmental Systems. 1-3 Credit Hours.**

The student conducts a laboratory or field investigation under the guidance of the faculty in the department. Proposals, indicating credits sought, must have approval prior to registration. Written research report and oral public presentation of the research are required. Prerequisites and corequisites: 15 credit hours in environmental science or biology in addition to BIO 380. For biology majors, three credits of BIO 499 carries credit for the 10th biology course. For ESS majors, three credits of ESS 499 is required for graduation.

Cross-listed Courses: ESS 499

## Biological Sciences (BSC)

**BSC 105. Exercise Physiology. 3 Credit Hours.**

This course studies the physiology of exercise, including concepts of work, muscle contraction, energy transformation, metabolism, oxygen debt, nutrition and athletic performance. Emphasis is placed on cardiovascular and respiratory function in relation to physical activity and training. No prerequisite. Three hours lecture/week. Does not carry biology major credit.

**BSC 110. Paleobiology - Dinosaurs & Their World. 3 Credit Hours.**

The term "paleobiology" encompasses the study of any ancient life, but this course focuses on a single group, the dinosaurs, an incredibly diverse assemblage of animals that dominated the ancient landscape for over 130 million years. The public appreciation and fascination with dinosaurs has grown steadily in the 180 years following their modern discovery. This course uses dinosaurs as a vehicle for a broader investigation of the biological and physical systems that comprise planet Earth, and the inter-related nature of these systems as they relate to the evolution and extinction of Earth's inhabitants over the vastness of geologic time. Does not carry biology major credit.

**BSC 111. Ecology and the Environment. 3 Credit Hours.**

This course focuses on basic ecological principles, especially the effects of human activities on our life-supporting environment. No prerequisite. Three hours lecture/ week. Does not carry biology major credit. This course may not be taken by biology majors as a free elective. Minors should consult with the department chair.

**BSC 114. Survival of the Fitness. 3 Credit Hours.**

This course will broadly examine the role of food, nutrition and exercise on the body. Current issues such as diabetes and obesity will be addressed from the lens of physical fitness and food intake. Students will survey their own fitness and participate in activities investigating the effects of physical activity on the body. Some class periods will be held in the recreation center. Does not carry biology major credit.

**BSC 115. Hormones and Your Health. 3 Credit Hours.**

This course for non-science majors, designed to fulfill the core science requirement, will introduce students to the importance of appropriate hormone function to their health. Students will learn basic concepts of hormone production, release, circulation throughout the body, and how hormones are required for proper body function. Alterations of normal hormone function by environmental toxins, one's health status and common medications will also be discussed. Three hours of lecture per week. Does not carry biology major credit.

**BSC 118. Medicine, Media, Myths: Fact Or Fiction?. 3 Credit Hours.**

This course for non-science majors is designed to fulfill the core science requirement. In this course, we will examine some important biological topics in the popular media including vaccines, bird flu, and stem cells. With inconsistent and ever-changing media attention, political bias, corporate spin, or lack of information, it is sometimes difficult to know what the real scientific evidence suggests. We will examine how well (or poorly) the public is informed about important medical issues through the popular media and compare this to what is published in the scientific literature. We will further examine the biological basis of these topics and discuss why they are important to us and future generations. This course will emphasize the importance of becoming informed and not just accepting what the media tells us. Does not carry major credit. Not open to Biology majors.

**BSC 125. Ethnobotany: The Plants People Use. 3 Credit Hours.**

This course examines plants and their biology, focusing on those used by people. Ethnobotany studies the use of plants in indigenous societies, but also fosters awareness of plants used by industrialized cultures and plants of historical importance. Fundamental scientific and botanical concepts advance an understanding of diet, herbal medicines, plant products in manufacturing, biotechnology and conservation biology. Three hours of lecture per week. Does not carry biology major credit.

**BSC 128. Global Ecosystems: Costa Rica. 3 Credit Hours.**

Understanding the function of ecosystems around the world, particularly those that exist within a sensitive climatic balance, is important for all students. This introductory course offers students the opportunity to study the fundamentals of evolution, ecology and earth science culminating in a two-week field experience in Costa Rica. Students will explore the principles of scientific investigation; comparisons of floral and faunal diversity in high-altitude (cloud) versus low-altitude (rain) forests; comparisons of highland and lowland soils; types of volcanic activity in an active volcanic arc; effects of volcanic activity on ecological diversity and soil formation; and operation of coastal processes on a geologically young coastline. Lectures, readings and discussions will be conducted at Le Moyne as well as at the field sites. Satisfies core science requirement. Additional fees will be required for this course. Does not carry biology major credit.

Cross-listed Courses: ESS 128

**BSC 129. Global Ecosystems: North America. 3 Credit Hours.**

This introductory level field course will offer students the opportunity to study the fundamentals of ecosystem and earth science, with specific reference to North America. This study will involve travel for two weekends in the Adirondacks and for an extended weekend to northern Arizona. Field-based learning activities will examine the geological and ecological processes that determine the structure and function of these two systems. Does not carry Biology major credit. Satisfies Core science requirement.

Cross-listed Courses: ESS 129

**BSC 135. Bodyworks: The Human Body. 3 Credit Hours.**

This one semester course provides a study of the human body from combined anatomical and physiological perspectives. This course will include a "hands on" experiential component in order for students to engage in the scientific process. Such activities as measurement of physiological responses, and study of both dissected specimens and three dimensional models of human organ systems will enhance student learning. Does not carry biology major credit. Satisfies NAT SCI 1 requirement.

**BSC 201. Human Anatomy & Physiology I. 4 Credit Hours.**

This course is the first in a two-semester sequence providing a study of anatomy and physiology in the human body. Initial portions of the course will include terminology, cell biology, biological chemistry, and tissues. Body systems covered include the skeletal, muscle, nervous, and integumentary. The cat is the primary dissection specimen in the laboratory. Dissection required. Pre-requisites: none. Three hours of lecture and two hours of laboratory per week. Does not carry biology major credit.

**BSC 202. Human Anatomy & Physiology II. 4 Credit Hours.**

This course is the second in a two-semester sequence providing a study of anatomy and physiology in the human body. Topics covered include the special senses, and the endocrine, circulatory, immune, respiratory, digestive, urinary and reproductive systems. Dissection required. Pre-requisites: a grade of C or better in BSC 201. Three hours of lecture and two hours of laboratory per week. Does not carry biology major credit.

**BSC 205. Basic Microbiology. 4 Credit Hours.**

This course is a survey of microbial life with special emphasis on those organisms of clinical interest. Laboratory exercises emphasize the isolation, identification and control of microorganisms. Three hours of lecture and two hours laboratory per week. Prerequisite or corequisite: BSC 201, 202. Does not carry biology major credit.

**BSC 210. Bugged: Insects in Human History. 3 Credit Hours.**

Insect species make up over 50% of all animal species known on this planet. Successful in every habitat on earth, they dominate the land and the air. They have evolved amazing adaptations, including external skeletons, the ability to communicate using light, sound and sight, the ability to fly and to survive freezing, mimicry, complex symbiotic relationships with other organisms...the list goes on and on. This course is an exploration of this diversity as described by science and how various insects have impacted humans throughout history, whether for good or ill, using historical and religious writings, myths and folktales, plays, film and contemporary media. We will examine topics as diverse as why scarabs were sacred to the ancient Egyptians, how plague spread throughout the world in two major pandemics, and why dragonflies are termed "devil's darning needles." While lecture will be used to present some of the material, discussion and group work based on material read or seen will be a major component of the course. (NOTE: THIS COURSE FULFILLS THE CORE REQUIREMENT FOR INTERDISCIPLINARY STUDIES(IDS) BUT DOES NOT FULFILL THE CORE REQUIREMENT FOR A NATURAL SCIENCE COURSE.). Prerequisite: COR 100.

**BSC 340. Brain and Behavior. 3 Credit Hours.**

A study of the relationship of the brain and body to behavior. Emphasis is on the central nervous system. Topics include neuroanatomy, neural cell processes, hemispheric functions, hormonal regulation of behavior, physiological mechanisms involved in attention, arousal and sleep, and the neural bases of emotions learning and memory and psychological disorders. Does not carry biology major credit. Prerequisites: PSY 101 or permission of the instructor.

Cross-listed Courses: PSY 340

**BSC 345. Pathophysiology. 3 Credit Hours.**

This course is a comprehensive coverage of the basic pathophysiological mechanisms and specific diseases and disorders affecting all of the major organ systems of the human body. The concepts of pathophysiology, especially for the most commonly encountered diseases and disorders, are covered in detail, including such topics as genetics/heredity, immune system problems, inflammation and infection, endocrinology, and malignant processes. The etiology and progression of disease and disorder states are examined from the micro (cellular) and macro (organ) level. Does not carry biology major credit. Registration for this course is limited to nursing majors, except by permission from the Chair of Nursing.

Prerequisites: BSC 201, BSC 202 and BSC 205.

**BSC 346. Phys Chg & Care Giv/ Wellness in Aging. 3 Credit Hours.**

This course will assist students to advise elders and their families with decisions related to lifestyle as the physical changes of aging become prominent forces in maintaining independence. The course content and activities will introduce the students to normal adult anatomy and physiology and the changes associated with aging. A body systems approach will be used to discuss age related changes in physical structure and function and the associated environmental and lifestyle practices that can support a healthy aging process. This course does not carry biology major credit.

## Environmental Science Systems (ESS)

### ESS 121. Global Resources. 3 Credit Hours.

Resources can be thought of as anything that an organism needs for survival. While this holds true for all life forms, in this class we will focus primarily on humans and human societies. The consumption of resources often results in a struggle for survival and this competition manifests itself at many levels, from the town and region (which tribes and ethnic groups have access to the best land and water supply); to the nation (control of the nation's oil, water, mines), and to the world at large. Does not carry biology major credit.

### ESS 128. Global Ecosystems: Costa Rica. 3 Credit Hours.

Understanding the function of ecosystems around the world, particularly those that exist within a sensitive climatic balance, is important for all students. This introductory course offers students the opportunity to study the fundamentals of evolution, ecology and earth science culminating in a two-week field experience in Costa Rica. Students will explore the principles of scientific investigation; comparisons of floral and faunal diversity in high-altitude (cloud) versus low-altitude (rain) forests; comparisons of highland and lowland soils; types of volcanic activity in an active volcanic arc; effects of volcanic activity on ecological diversity and soil formation; and operation of coastal processes on a geologically young coastline. Lectures, readings and discussions will be conducted at Le Moyne as well as at the field sites. Satisfies core science requirement. Additional fees will be required for this course. Does not carry biology major credit.

Cross-listed Courses: BSC 128

### ESS 129. Global Ecosystems: North America. 3 Credit Hours.

This introductory level field course will offer students the opportunity to study the fundamentals of ecosystem and earth science, with specific reference to North America. This study will involve travel for two weekends in the Adirondacks and for an extended weekend to northern Arizona. Field-based learning activities will examine the geological and ecological processes that determine the structure and function of these two systems. Does not carry Biology major credit. Satisfies core science requirement. Additional fees will be required for this course. Does not carry biology major credit.

Cross-listed Courses: BSC 129

### ESS 203. The Papal Climate Encyclical Critically explored. 3 Credit Hours.

This exploration of Laudato Si by Le Moyne College and SUNY College of Environmental Science and Forestry draws faculty and students to critically evaluate the case laid out in the encyclical that all humans have a responsibility to care for the Earth, "Our Common Home." It seeks to provide both a focus and a foundation to the question, how might we join together as environmental scientists, scholars and advocates for collaboration among secular and religious institutions as well as faith-based environmental activists? Counts as a major elective for ESS majors. Student carpooling will be arranged for transportation to the meeting location for this class. Prerequisite: EITHER one course in biology or environmental science [for ESS elective credit]; or one course in theology OR Junior standing or permission of the Instructor. Fulfills Core Requirement(s): Interdisciplinary Studies (IDS).

### ESS 205. Physical Geology. 4 Credit Hours.

Physical Geology is an introduction to the study of the composition of the Earth and the processes that operate internally and at the surface. Students are introduced to basic geological concepts including plate tectonics, volcanoes, earthquakes, geologic time, types of rocks that form the crust and how they form, and surficial processes. Three hours lecture and three hours of laboratory per week. Does not carry biology major credit.

### ESS 237. Ecology of the Galapagos. 3 Credit Hours.

This course allows students to study, in both classroom and field settings, the delicate balance between geological, biological, climatologic and anthropogenic processes in shaping ecological environments, with specific focus on the biogeography of tropical islands. The Galapagos Archipelago is a singular locale where the fragile nature of the environment, the processes that shape it, and the unique nature of its inhabitants are readily observed. Additionally, the historic significance of this locale in the development of one of the foundational theories of modern science will be explored fully. Additional expense for required travel component. Carries BIO and ESS major credit.

Prerequisite: BIO 191 and BIO 192.

Cross-listed Courses: BIO 237

### ESS 238. History of Earth and Its Inhabitants. 4 Credit Hours.

This course utilizes readings, lectures, laboratory activities and field trips to examine the physical changes that have occurred on the surface of our planet and the history of life on earth. Key concepts include the tectonic evolution of North America and the fossil record of evolution, with emphasis on the geologic history of the New York region. Some travel may occur on weekends. Does not carry biology major credit.

Prerequisites: BSC/ESS 127, 128, 129 or ESS 205 or permission of instructor.

### ESS 250. Water Resources. 4 Credit Hours.

This course shows the variety of ways that water impacts on the natural and man-made worlds. One of the original four 'elements', water is becoming more vital than ever, as a consequence of the continuing increases in human population, pollution, and changes in climate. The course explores the ancient concept of the water cycle in a modern context to give an appreciation of the importance of water and water quality to plants, animals and humans. Three hours lecture, three hours laboratory per week. Carries ESS major credit. Recommended: ESS 205. Does not carry biology major credit.

Prerequisites: CHM 151 and CHM 152.

### ESS 260. Sustainability: Ecological Entrepreneurship. 3 Credit Hours.

The concept and practice of Sustainable Growth and Development have generated increasing concern over the past four decades. Recently, due to a heightened focus on climate change, ecological damage, rising inequalities of resource distribution, etc., even more attention and effort have been directed toward the concept of Sustainability. This course explores the connections among science, technology, products, and markets in the service of society, (emphasizing that none of these forces works in a vacuum), in order to study the many aspects of sustainability. Students are encouraged to be entrepreneurs of sustainability, acting to find a balance among social, ecological, and economic needs. Course satisfies Core Natural Science requirement. Sophomore standing or permission of the instructor. Does not carry biology major credit.

Cross-listed Courses: ENS 260

**ESS 265. Intro to Geographic Info Systems. 3 Credit Hours.**

This course is designed to introduce students to Geographic Information Systems (GIS), a set of hardware, software, and methods for the capture, storage, management, manipulations, analysis, modeling, and display of geographic information. This course will provide an introduction to GIS application and analysis. Course work will emphasize use of industry standard software. Two hours lecture, two hours lab per week. Carries BIO and ESS major credit.

Cross-listed Courses: BIO 265

**ESS 310. Field Ornithology. 4 Credit Hours.**

This course will cover basic bird physiology, ecology, and conservation biology with a strong emphasis on field ecology. Students will be required to actively engage in bird identification, behavioral observation, and field data collection. This course will provide students with an extensive field experience aimed at broadening their view of the biological world around them. A major component to this course will be a Spring Break experience in southern Texas. Attaining experience in different ecoregions supplies students with a valuable perspective for thinking more broadly about biology. Additional expenses-travel expenses round-trip to McAllen, TX. Students must meet with the instructor before registration. Prerequisite(s): BIO 191 BIO 192.

Cross-listed Courses: BIO 310

**ESS 320. Earth's Surface. 4 Credit Hours.**

This course describes the interaction of sedimentary, hydrologic, and biologic processes at the surface of the Earth, with particular attention to the role of organisms and climate on the formation and erosion of soils. Topics will include sedimentary processes, landforms, surficial hydrology, pedogenesis, fluvial and glacial processes and landforms. Significant fieldwork and mapping applications will be a part of this course. Three hours of lecture and three hours of laboratory per week are required. Does not carry biology major credit.

Prerequisites: ESS 205 or permission.

**ESS 335. Biodiversity. 3 Credit Hours.**

This course is designed to acquaint the student with the phenomenal diversity of life with which we share this planet. To do this we will refresh the students memories concerning evolution and the various mechanisms through which communities of life forms have become adapted to their environment. We will spend some time with taxonomy and biogeography before we can begin to examine the current state of biodiversity as well as future trends. The implications of these trends will signal a stopping point for the course but will hopefully serve as a beginning for the student as they move away from Le Moyne and take a place in society.

Prerequisites: Minimum of 10 BIO/ESS credits.

Cross-listed Courses: BIO 335

**ESS 340. Environmental Chemistry. 3 Credit Hours.**

The focus of this course is on understanding the underlying chemical principles and reactions of natural systems and anthropogenic compounds in the environment. Topics such as chemistry of the atmosphere, aqueous media, pollutants and energy sources will be covered. The emphasis of the course is on chemical aspects of environmental science, so a general background in chemistry is a prerequisite. Does not carry biology major credit.

Prerequisites: CHM 223.

Cross-listed Courses: CHM 340

**ESS 340L. Environmental Chemistry Laboratory. 1 Credit Hour.**

This is an optional laboratory course that further explores topics covered in the lecture course. The lecture course (NSS 340) may be taken with or without this lab course (NSS 340L). Emphasis is on analytical methods, green chemistry techniques and investigation of materials. Three hours laboratory each week.

Cross-listed Courses: CHM 340L

**ESS 348. Environ Research in the Field: Iceland. 4 Credit Hours.**

The environment of Iceland is shaped by the immensely dynamic geologic processes of active volcanoes and glaciers, but this environment is also deceptively fragile and subject to anthropogenic influence. The present landscape has resulted from this interaction of human and natural processes. A semester of classroom activity culminates in a field session where students conduct research on the processes of environmental change in Iceland.

Cross-listed Courses: BIO 348

**ESS 390. Independent Study in Biological & Natural Systems. 1-3 Credit Hours.**

A student may pursue a semester or more of independent study in a specialized area of biology of mutual interest to the student and one or more members of the faculty in the department. This course is for the above average student whose interests and abilities go farther than normal course offerings. Proposals, indicating credit sought, must have approval prior to registration. Prerequisites or corequisites: 15 credit hours in biology in addition to B10 380. Carries biology major credit for the tenth biology course.

Cross-listed Courses: BIO 390

**ESS 420. Special Topic: Field Botany. 4 Credit Hours.**

The four-credit course will survey the flora of central New York, with excursions to various habitats including grasslands, sand dunes, peat bogs, old-growth forests, and wetlands. Plant identification and systematics will be the major focus, and students will learn how to create and curate an herbarium, compare the species composition of the various habitats, and learn human impacts and the importance of conservation of natural habitats and native species. The six hour block allows for travel and time in the field.

Prerequisites: BIO 191 and BIO 192.

Cross-listed Courses: BIO 420

**ESS 421. Special Topic: Research in Tropical Biology. 4 Credit Hours.**

A variety of ecosystems exist throughout the tropics and are home to the majority of the terrestrial biodiversity found around the globe. Studies of organismal interactions and species diversity are still leading to the creation of new scientific knowledge and discovery of new species, and Costa Rica represents a county with diverse tropical forests that form the basis for many of these discoveries. This upper-level field-experience course will allow students to search, analyze and interpret the scientific literature during classroom activities at Le Moyne College, then apply the scientific process through observation, experimentation, and hypothesis testing during a three-week session in Costa Rica. Additional fees will be required for this course. Carries BIO and ESS major credit.

Prerequisites: BIO 191 and BIO 192 and junior or senior standing in the Biological sciences, Biochemistry, or Environmental Science Systems, and permission of the instructors.

Cross-listed Courses: BIO 421

**ESS 421L. Research in Tropical Biology Lab. 0 Credit Hour.****ESS 458. Global Climate Systems. 3 Credit Hours.**

In this class, students will come to recognize that Earth's biosphere, atmosphere, hydrosphere, and geosphere operate in complexly linked systems in which various components are exchanged over greatly varying time scales. Using laboratory and field studies, students will measure, discuss and define the impact of global change on natural systems.

Prerequisites: CHM 151 and CHM 152 and a minimum of 15 credits of BIO, including at least one course in the Ecology/Population Biology Area.

Cross-listed Courses: BIO 458

**ESS 470. Seminar: Environmental Topics. 3 Credit Hours.**

This advanced seminar provides students with the opportunity to explore the complexity of environmental issues in detail. By choosing current topics and analyzing the scientific and socio-economic factors underlying environmental problems, students will develop greater awareness and understanding of society's ability to mitigate these problems. Carries BIO and ESS major credit. This course places a high emphasis on oral and written presentation skills.

Prerequisites: 20 credits in BIO, ESS, PSC, ECO from 200, 300 or 400 level courses.

Cross-listed Courses: BIO 470, PSC 470

**ESS 490. Internship in Environmental Science. 1-3 Credit Hours.**

The goal of this class is participation in a field-learning experience closely related to the student's major field of study. The student intern will meet regularly with his or her supervisor in the agency and will report as required to the faculty member assigned to supervise the internship. Students are expected to apply what they have learned in the academic program to the internship. An evaluation of the experience will also be required. The internship and placement must be approved by the faculty coordinator. Three hours of field work per week are required to generate one credit hour. Therefore, a three-credit internship will require at least nine hours on site per week. The number of credit hours to be awarded must be determined and contracted prior to registration. A signed Memorandum of Understanding (MOU) with the placement site must be on file with the Office of Career Services prior to the start of the internship experience.

Prerequisite: 64 credit hours of coursework in the major program or permission of the department chair.

**ESS 499. Research in Bio & Environmental Systems. 1-3 Credit Hours.**

The student conducts a laboratory or field investigation under the guidance of the faculty in the department. Proposals, indicating credits sought, must have approval prior to registration. Written research report and oral public presentation of the research are required. prerequisites and corequisites: 15 credit hours in environmental science or biology in addition to BIO 380. For biology majors, three credits of BIO 499 carries credit for the 10th biology course. For ESS majors, three credits of ESS 499 is required for graduation.

Cross-listed Courses: BIO 499