

# Biology

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**Professors:** *Grogan, King Smith (Chair), McCann (on sabbatical Spring '16), McRobert, Snetselaar (on sabbatical Spring '16)*

**Associate Professors:** *Fingerut, Lee-Soety, Springer (on sabbatical Fall '15)*

**Assistant Professors:** *Arango, Bhatt, Braverman, S.J., Li, Nelson*

**Core Laboratory Coordinator:** *Ratterman*

**GEP Laboratory Coordinator:** *Forster*

**Associate Professor Emeritus:** *Tefft*

**Professor Emeriti:** *Tudor, Watrous*

## Program Overview

The undergraduate Biology curriculum begins with a core of courses that presents the fundamentals of the life sciences, both in concept and methodology. After completing the core, students take a distribution of upper division courses with at least one course in each of the three major areas of biology. This distribution strategy insures that all students have broad exposure to an extensive range of topics including cell and molecular biology, microbiology, genetics, plant biology, evolution, physiology, ecology, environmental biology, and animal behavior. The curriculum provides appropriate training for students seeking admission to professional and graduate schools and those who wish to enter the job market directly following graduation.

The faculty of the Department of Biology view teaching as the primary mission of both the Department and the University. In addition, Biology faculty are involved in high caliber scientific research. The interplay between teaching and research, and the involvement of students in faculty research strengthens the Biology curriculum. One of the most important qualities of the Department is the opportunity for undergraduates to participate in faculty research. This mentor-student relationship involves the design and execution of experiments, and is a very enriching learning experience. Students can work with faculty as volunteers, for academic credit, or for pay during the summer months. The research done by students often leads to publications and presentations at national and regional conferences. Whatever the career plans, students are encouraged to seriously consider participating in undergraduate research. Up to two semesters of research may be counted as biology electives.

The Department of Biology also has a small but strong graduate program that leads to either a MS or a MA degree in biology. The MA degree is primarily designed for post-graduates who are working or wishing to improve their credentials for professional school. The MS degree requires the development and presentation of a thesis based on original research. This degree is more appropriate for full-time students wishing to engage in research as part of a career or as a prelude to graduate training at the doctoral level. Students in the MS program may be eligible for a teaching assistantship that provides a tuition scholarship and stipend. The presence of diverse and engaged graduate students enhances both faculty research and the academic experience for undergraduate students.

## Program Mission

The Biology program has as its aim the education of broadly trained biologists who are well grounded in chemistry, physics, and mathematics, and have command of the written and spoken word. Emphasis is placed on understanding basic principles and concepts in biology, and the application of those principles through analysis of data and synthesis of information learned in the classroom and the research laboratory. The Biology program has always been known as a training ground for individuals pursuing professional careers in the life sciences. Many graduates from the Biology program have gone on to professional schools, pursued graduate studies, or entered the work force directly in academic, government, and industrial labs. This requires that our students be prepared to face the challenges of a competitive world. To help them meet these challenges the Department of Biology has established a strong advising program. Faculty commitment to academic advising and accessibility of faculty advisors to students exemplifies the institutional mission of *cura personalis*.

## Learning Goals and Objectives for the B.S. in Biology

**Goal 1:** Students will gain an appreciation and understanding of cell structure and function, the organization of biological systems, and the evolution of biological diversity.

**Objective 1.1:** Students will be able to describe evolution and the basic mechanisms of evolutionary change.

**Objective 1.2:** Students will demonstrate knowledge of the major domains of life on earth and the distinctive characteristics of major groups.

**Objective 1.3:** Students will demonstrate knowledge of anabolic and catabolic pathways used by living organisms to provide energy and macromolecules for synthesis.

**Objective 1.4:** Students will be able to describe the components of the major trophic levels and diagram the flow of nutrients through food webs in the environment.

**Objective 1.5:** Students will be able to describe how organisms respond to physiological, environmental and physical challenges.

**Objective 1.6:** Students will be able to describe the role of genetics at both cellular and organismal levels.

**Objective 1.7:** Students will demonstrate an understanding of the importance of protein structure and function.

**Goal 2:** Students will develop skills in experimental design, surveying of scientific literature, data collection, and the interpretation of results, including statistical analysis.

**Objective 2.1:** Students will demonstrate competency in operating basic laboratory equipment.

**Objective 2.2:** Students will demonstrate competency in data reduction and presentation, including choosing and interpreting the appropriate statistical tests.

**Goal 3:** Students will develop skills in presenting scientific information both orally and in writing.

**Objective 3.1:** Students will be able to develop cogent, well structured, and researched written and oral presentations of scientific content.

### Requirements for the Biology Major

**GEP Signature Courses (See Curricula): six courses**

**GEP Variable Courses (See Curricula): six to nine courses, including**

#### Mathematics:

MAT 155 Fundamentals of Calculus

OR  
MAT 161 Calculus I

#### Natural Science:

BIO 101 Biology I: Cells (first semester freshman year)

**GEP Overlays (See Curricula): three courses**

**GEP Integrative Learning Component: three courses**

#### Chemistry:

CHM 120 General Chemistry I (*first semester freshman year*)

CHM 120L General Chemistry Laboratory I (*first semester freshman year*)

CHM 210 Organic Chemistry I (*first semester sophomore year*)

CHM 210L Organic Chemistry I Lab (*first semester sophomore year*)

#### Physics:

PHY 101 General Physics I (*first semester junior year*)

PHY 101L General Physics Laboratory I (*first semester junior year*)

**GEP Electives: at least six courses\***

**Major Concentration: thirteen courses**

#### Biology

BIO 102 Biology II: Genetic and Evolutionary Biology (*second semester freshman year*)

BIO 201 Biology III: Organismic Biology (*first semester sophomore year*)

BIO 390 Seminar (*required each semester for sophomores, juniors, and seniors.*)

**One course from each of the following groups:**

#### Group A: Cell Structure and Function

BIO 402 Advanced Cell Biology

BIO 404 Biochemistry

BIO 408 Histology

BIO 410 Light and Electron Microscopy

BIO 411 Molecular Genetics

BIO 412 Neurobiology

BIO 416 Microbiology

BIO 421 Molecular and Cellular Biophysics

#### Group B: Systemic Organization

BIO 403 Biometrics and Modeling

BIO 405 Biomechanics

BIO 407 Developmental Biology

BIO 413 Plant Physiological Ecology

BIO 415 Immunology

BIO 417 Systemic Physiology

BIO 425 Bacterial Pathogenesis

### **Group C: Evolution and Diversity of Life**

BIO 401	Animal Behavior
BIO 409	Ecology
BIO 406	Comparative Anatomy
BIO 414	Plant Systematics
BIO 419	Invertebrate Zoology
BIO 420	Bioinformatics
BIO 422	Applied and Environmental Microbiology
BIO 423	Evolution

*Four additional 400-level biology courses*

*BIO 101,102, 201 and CHM 120, 125 are prerequisite for all 400 level BIO courses.*

### **Chemistry**

CHM 125	General Chemistry II ( <i>second semester freshman year</i> )
CHM 125L	General Chemistry Laboratory II ( <i>second semester freshman year</i> )
CHM 215	Organic Chemistry II ( <i>second semester sophomore year</i> )
CHM 215L	Organic Chemistry Laboratory II ( <i>second semester sophomore year</i> )

### **Mathematics:**

MAT 128	Applied Statistics ( <i>first semester sophomore year</i> )
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### **Physics**

PHY 102	General Physics II ( <i>second semester junior year</i> )
PHY 102L	General Physics Laboratory II ( <i>second semester junior year</i> )

\*Biology majors may graduate with 38 or 39 courses instead of the usual 40 course requirement. The student retains the option to take 40 courses.

*Note:* Directed readings, special topics Biology Graduate courses and other Biology courses without a lab component can only be counted as a Biology elective and in most cases no more than one such non-lab course may be applied to this requirement. Students with the appropriate Mathematics background and interests can substitute University Physics for General Physics.

### **Requirements for College Honors**

To receive College Honors credit, students will undertake two consecutive semesters of research and study that culminates in a senior thesis. Alternatively, students may enroll in the honors section of a 400-level biology elective that includes additional research and a research paper. Two such courses must be taken consecutively during the senior year. To be eligible for College Honors, a student must have a 3.5 GPA or higher. Students interested in completing College Honors during the senior year must contact the department chair

early in the spring semester of the junior year. For students in the Honors Program, either honors thesis research or honors 400-level course may be counted toward the eight- course Honors requirement.

### **Five Year Combined B.S. in Biology/M.S. in Education Option**

For students who entered SJU before the fall of 2010, or transfer students who entered SJU in the fall of 2010 with 15 or more credits:

This program allows a student to complete in five years the requirements for both the B.S. in Biology and M.S. in Education degrees with certification to teach biology by permitting an undergraduate student to begin graduate coursework in Education during his/her senior year. The program features: (1) an independent faculty-directed research project in biology in the summer between the fourth and fifth years, (2) two graduate courses in biology, and (3) seven graduate courses in education, including a one semester student teaching experience. A student should apply to the Chair of the Department of Biology for admission to this program by the second semester of his/her junior year at the latest. It is anticipated that the graduates of this program will be highly competitive in the rapidly expanding market for qualified high school biology teachers.

For students who entered SJU in the fall of 2010 or later, or transfer students who entered SJU in the fall of 2010 with 14 or fewer credits:

The Pennsylvania Department of Education requirements and program of study sequence for students under the GEP have not yet been finalized. This section of the catalog will be updated as soon as the requirements are in place. Students interested in the five year program should speak to their academic advisors and to Chair of the Department of Biology as early in their academic careers as possible.

### **B.A. in Biology/B.S. in Secondary Education Dual Major**

The Bachelor of Arts degree in Biology is for students who wish to pursue a dual major with Secondary Education (B.S.). The B.A. degree is only available for students who pursue the dual major.

Requirements for the B.A. in Biology: become certified to teach at the secondary education level (grades 7-12), students must complete a total of five Education and three Special Education courses,

and student teaching. For further details, see the Teacher Education section of the catalog. Students interested in the five-year program should speak to their academic advisors and to Chair of the Department of Biology as early in their academic careers as possible.

**GEP Signature Courses (See Curricula): six courses**

First Year Seminar:

EDU 150 Schools in Society

**GEP Variable Courses (See Curricula): six to nine courses, including**

**Mathematics:**

Math beauty

**Natural Science:**

BIO 101 Biology I: Cells (first semester freshman year)

**GEP Overlays (See Curricula): three courses**

**GEP Integrative Learning Component: three courses**

**Chemistry:**

CHM 120 General Chemistry I (first semester freshman year)

CHM 120L General Chemistry Laboratory I (first semester freshman year)

CHM 210 Organic Chemistry I (first semester sophomore year)

CHM 210L Organic Chemistry I Lab (first semester sophomore year)

**Environmental Science:**

ENV 106 Exploring the Earth (first semester senior year)

**GEP Electives: at least six courses\***

**Major Concentration: thirteen courses**

**Biology**

BIO 102 Biology II: Genetic and Evolutionary Biology (second semester freshman year)

BIO 201 Biology III: Organismic Biology (first semester sophomore year)

BIO 390 Seminar (Required each semester for sophomores and juniors)

**One course from each of the following four groups:**

1.

BIO 406 Comparative Anatomy

BIO 407 Developmental Biology

BIO 417 Systemic Physiology

2.

BIO 416 Microbiology

BIO 419 Invertebrate Zoology

3.

BIO 409 Ecology

BIO 423 Evolution

4.

BIO 413 Plant Physiological Ecology

BIO 414 Plant Systematics

*BIO 101,102, 201 and CHM 120, 125 are prerequisite for all 400 level BIO courses.*

**Chemistry**

CHM 125 General Chemistry II (second semester freshman year)

CHM 125L General Chemistry Laboratory II (second semester freshman year)

CHM 215 Organic Chemistry II (second semester sophomore year)

CHM 215L Organic Chemistry Laboratory II (second semester sophomore year)

**Mathematics:**

MAT 128 Applied Statistics (first semester sophomore year)

**Physics:**

PHY 101 General Physics I (first semester junior year)

PHY 101L General Physics Laboratory I (second semester junior year)

PHY 102 General Physics II (second semester junior year)

PHY 102L General Physics Laboratory II (second semester junior year)

**Advisory Option—Biology Pre-Professional**

Biology majors may satisfy entrance requirements for medical, dental, osteopathic medical, and other schools of the health professions. Students are advised to take elective courses in liberal arts and behavioral sciences.

**Minor in Biology**

The minor in biology requires completion of CHM 120, 125, 120L, 125L, BIO 101, 102, and 201, along with three additional courses in the 400 series representing at least two of the course groups (A, B, C) listed above.

**Learning Goals and Objectives for the minor in Biology**

**Goal 1:** Students will gain a fundamental understanding of biological systems.

**Objective 1.1:** Students will understand concepts of basic cellular structure and function.

**Objective 1.2:** Students will demonstrate knowledge of the organization of biological systems.

**Objective 1.3:** Students will understand basic concepts concerning the evolution of biological diversity.

**Goal 2:** Students will develop basic skills in the practice of experimental inquiry into biological systems.

**Objective 2.1:** Students will understand the rudiments of experimental design.

**Objective 2.2:** Students will be competent in the operation of basic laboratory equipment.

**Objective 2.3:** Students will be competent in data collection, interpretation, and the communication of research findings in written and oral form.

### **Biology in the GEP (See Curricula)**

The GEP requires that all students take EITHER one semester of a lab-based natural science course (6 contact hours) OR two semesters of lecture-only natural science courses. Students who wish to satisfy the natural science GEP by completing courses in Biology may do so by taking the first semester of the Biology majors, lab-based course sequence, BIO 101, or one of the lab-based, one-semester courses for non-science majors, as they become available. Alternatively, students may fulfill one or both semesters of the natural science GEP by completing one or two of the special one-semester lecture-only Biology courses designed for non-science majors listed below.

### **Non-science majors Biology GEP lecture-only courses:**

BIO 160	Heredity and Evolution
BIO 161	The Human Organism
BIO 162	Plants and Civilization

### **Non-science majors Biology GEP lab-based courses:**

BIO 165	Exploring the Living World
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## **Biology Courses**

### **BIO 101 Biology I: Cells (4 credits)**

The study of the structure and function of representative prokaryotic and eukaryotic cells. Chemical makeup, organelle interactions, energy producing and biosynthetic reactions will be stressed. *Three lecture periods, one three-hour laboratory period (BIO 101L or 150L). First of three courses in the core program.*

### **BIO 102 Biology II: Genetic and Evolutionary Biology (4 credits)**

The study of heredity and the mechanism of transmission of genetic information in biological systems. The course material is approached from the population, organismic, and biochemical perspectives. *Three lecture periods, one three-hour laboratory period (BIO 102L or 151L). Prerequisite: BIO 101.*

### **BIO 150: The Science of Learning: Learning Science (3 credits)**

A first year seminar focusing on the science that underlies how we learn and application of that to teaching and learning science, with a focus on biology. Students will read literature on learning that ranges from how the brain works to current evidenced-based studies of effective ways to teach and learn science. Students will put this new knowledge to work immediately by analyzing their own learning and by designing and teaching hands-on science units to children. Co-requisite: BIO 101.

### **BIO 150L : Cells Laboratory Phage Genomics (alternative laboratory for BIO 101)**

A research-based laboratory for freshman accompanying BIO 101 involving isolation, purification, and preliminary genomic characterization of bacteriophages, viruses that infect bacteria. *Open to first year students majoring in Biology, Chemical-Biology, or Environmental Science. Admission by application. Successful completion of BIO101 and 150L fulfills the first year seminar GEP requirement. Students are expected to continue with BIO 151L in the spring. Two 75-minute lab periods.*

### **BIO 151L: Genetics Laboratory Phage Genomics (alternative laboratory for BIO 102)**

A continuation of BIO 150L, this laboratory is conducted in silico to annotate bacteriophage genomes isolated during the fall semester. Complete annotated genomes will be submitted

to GenBank. *Open to first year students majoring in Biology, Chemical Biology, or Environmental Science. Admission by application. Two 75-minute lab periods.*

**BIO 151L: Wormy Genes Lab (alternative laboratory for BIO 102)**

Using tiny round worms, *C. elegans*, students will participate in authentic research experience and learn about gene expression. State-of-the-art RNA interference technique is used to investigate function of gene products. *Open to first year students majoring in Biology, Chemical Biology, or Environmental Science. Admission by application. Two 75-minute lab periods.*

**BIO 160 Heredity and Evolution (3 credits)**

A study of human genetics at three levels: human heredity and the inheritance of disease, genes and DNA, and human evolution. Includes discussion of how a cell uses its genetic information and how scientists study genes using genetic engineering techniques. Successful completion of this course satisfies one of the Natural Science requirements in the GER/GEP. Open to all students except those who have credit for BIO 102. Three lecture periods.

**BIO 161 The Human Organism (3 credits)**

A study of the basic principles of human anatomy, physiology, and genetics. The organization and function of the human body will be described with an appreciation of underlying genetic and evolutionary concepts. Successful completion of this course satisfies one of the Natural Science requirements in the GER/GEP. *Open to all students except those who have credit for BIO 201 or 260. Three lecture periods.*

**BIO 162 Plants and Civilization (3 credits)**

This course will examine plants in the context of their importance to people. Plants used for food, fiber, medicine, and recreation will be included. Successful completion of this course satisfies one of the Natural Science requirements in the GEP. *Open to all students except biology majors. Biology majors need permission of the Biology Chair to take this course. Three lecture periods.*

**BIO 165 Exploring the Living World (4 Credits)**

Students in this course will learn about the scientific world view and experience the methods of science in the context of the life sciences. This course is designed for students not planning to major in science. The course includes a survey of plant and animal life, an overview of bioenergetics,

and selected topics in genetics and evolutionary biology. Successful completion of this course fully satisfies the GEP Natural Science requirement. *Three lecture periods and one three hour laboratory.*

**BIO 201 Biology III: Organismic Biology (4 credits)**

A survey of all living things followed by more detailed study of plants and animals. Topics include development, nutrition, locomotion, transport, and homeostatic controls. *Three lecture periods, one three-hour laboratory period. Prerequisites: BIO 101 and 102.*

**BIO 260 Anatomy and Physiology for Nursing/Allied Health I (4 credits)**

This course is designed for students needing preparation in human anatomy and physiology as required for nursing and some allied health programs. It does not fulfill a requirement for a Biology major or minor, nor does it fulfill general education requirements. Students may count either BIO 260 plus BIO 261 or BIO 417 toward graduation, but not both. *Prerequisites: BIO 101 or BIO 165. Three 50-minute lecture periods and one three-hour lab period.*

**BIO 261 Anatomy and Physiology for Nursing/Allied Health II (4 credits)**

Continuation of BIO 260. This course is designed for students needing preparation in human anatomy and physiology as required for nursing and some allied health programs. It does not fulfill a requirement for a Biology major or minor, nor does it fulfill general education requirements. Students may count either BIO 260 plus BIO 261 or BIO 417 toward graduation, but not both. *Prerequisite: BIO 260. Three 50-minute lecture periods and one three-hour lab period.*

**BIO 270 Microbiology for Nursing/Allied Health (4 credits)**

This course is designed for students needing preparation in microbiology as required for nursing and some allied health programs. It does not fulfill a requirement for the Biology major or minor, nor does it fulfill general education requirements. *Not open to students who have taken BIO 416 or BIO 422. Prerequisites: BIO 101 or BIO 165. Three 50-minute lecture periods and one three-hour lab period.*

**BIO 320 Science Education Service Learning Seminar (1 credit)**

Optional Service Learning course can be taken in conjunction with any Biology course. Guided experience in preparing and presenting hands-on science lessons to K-12 children. Time commitment is 3 hrs per week.

**BIO 360 God and Evolution (3 credits)**

This course considers a major topic in academic discourse and society at large, the relationship between religion/theology and biological evolution. This course explores the thesis that the two can be compatible—including from an informed scientific point of view. Students in this course learn evolutionary biology, theological account of creation, and how they can be compatible. Prerequisites: THE 154, PHL 154. This course fulfills the "Faith and Reason" requirement of the GEP. *It does not fulfill requirements for a Biology major or minor.*

**BIO 390 Seminar Non-credit**

Attendance at three seminars is required each semester during sophomore, junior, and senior years. Approved seminars are posted in the Department. *Graded on a P/NP basis.*  
*Prerequisite for all 400-level BIO courses: BIO 101, 102, 201, CHM 120/120L and 125/125L or permission of the Chair.*

**BIO 401 Animal Behavior (4 credits)**

The study of animals and their behaviors, with a strong emphasis on evolutionary relationships and ecology. Live animals will be studied in the classroom, laboratory, and field. *Two 50-minute lecture periods, one four-hour laboratory period.*  
*Prerequisites: BIO 201 and CHM 125.*

**BIO 402 Advanced Cell Biology (4 credits)**

An in-depth analysis of eukaryotic cell structure and function, including membrane structure and transport, cellular organelles, the cytoskeleton, and cell communication. Emphasis will be on experimental approaches to understanding concepts in cell biology. *Two 50-minute lecture periods, one four-hour laboratory period.*  
*Prerequisites: BIO 201 and CHM 125.*

**BIO 403 Biometrics and Modeling (4 credits)**

Computer simulation of life science phenomena from the subcellular to population levels. Appropriate statistics are included along with exposure to simulation software. Three 50-minute

lecture periods, one three-hour laboratory period.  
*Prerequisites: BIO 201 and CHM 125.*

**BIO 404 Biochemistry (3 credits)**

An introduction to the chemistry of living systems. The study of important macromolecules, metabolic pathways, and control systems will be emphasized. *Prerequisites: general chemistry and organic chemistry; second semester organic chemistry may be taken concurrently.* *Two seventy-five minute lecture periods.* *Prerequisites: BIO 201, CHM 125, CHM 210.*

**BIO 405 Biomechanics (4 credits)**

The role of physics in biological systems and the organismal and super-organismal level. Lectures will cover a range of biomechanics disciplines, presenting underlying physical principles and their biological ramifications. Laboratories will provide experience with the experimental techniques available to measure forces relevant to biological systems. *Two 75-minute lecture periods, one three-hour laboratory period.* *Prerequisites: BIO 201, CHM 125 and either PHY101 or PHY 105.*

**BIO 406 Comparative Anatomy (4 credits)**

An integrated comparative study of vertebrate structure and development. A synthesis of the embryological development, the gross anatomy, and the histology of selected forms. *Two 75-minute lecture periods, one three-hour laboratory period.* *Prerequisites: BIO 201 and CHM 125.*

**BIO 407 Developmental Biology (4 credits)**

A study of the molecular and cellular aspects of development. Emphasis will be on induction, regeneration, and genetic control of differentiation. *Two 50-minute lecture periods, one four-hour laboratory period.* *Prerequisites: BIO 201 and CHM 125.*

**BIO 408 Histology (4 credits)**

A study in depth of the microscopic structure and function of normal cells, tissues and organs as found in the vertebrates. Students will make extensive use of computer imaging, CD-ROM presentations and biological specimens for study in the laboratory. *Two three-hour sessions per week.*  
*Prerequisites: BIO 201 and CHM 125.*

**BIO 409 Ecology (4 credits)**

A study of the complex interrelationship between organisms and their environment. The course will include discussions on fundamental themes in

ecology such as food webs and population growth, as well as topics of current interest such as oil spills and the destruction of the rain forest. *Two 50-minute lecture periods, one four-hour laboratory period.*

*Prerequisites: BIO 201 and CHM 125.*

#### **BIO 410 Light and Electron Microscopy (4 credits)**

A course in techniques of light and electron microscopy, including aspects of technique, theory, and operation through lecture, demonstration, and student exercises. Time for individual use of the confocal and electron microscopes will be provided. A special fee will be assessed. *Two 50-minute lecture periods, one four-hour laboratory period.*

*Prerequisites: BIO 201 and CHM 125.*

#### **BIO 411 Molecular Genetics (4 credits)**

A study of the molecular biology of the genetic material, its structure, expression, regulation, and its dynamic nature. The laboratory consists of basic experiments in gene manipulation and recombinant DNA techniques. *Two 50-minute lecture periods, one four-hour laboratory period.*

*Prerequisites: BIO 201 and CHM 125.*

#### **BIO 412 Neurobiology (4 credits)**

A study of neural activity using examples from invertebrate and vertebrate model systems. The emphasis will be at the cellular and tissue levels with appropriate neurochemistry and pharmacology included. Laboratory work will focus on computer simulation of neural processes including simple nerve nets. *Two 50-minute lecture periods, one four-hour laboratory period.*

*Prerequisites: BIO 201 and CHM 125.*

#### **BIO 413 Plant Physiological Ecology (4 credits)**

This course will focus on the physiological mechanisms plants use to respond to their environment. Major topic areas include the basic environmental physiology of carbon, water, and mineral nutrient exchange, and the adaptive mechanisms plants use to survive the variety of global environments. Labs will cover common physiological research methods ranging from cellular to whole organism level measurements and will involve both laboratory and field work. *Three 50-minute lecture periods, one four-hour laboratory period.*

*Prerequisites: BIO 201 and CHM 125.*

#### **BIO 414 Plant Systematics (4 credits)**

Students will learn to recognize vascular plant families and understand how taxonomists study evolutionary relationships among plant groups. Economic, medical, and ecological importance of various seed plants will be emphasized. *Three 50-minute lecture periods, one three-hour laboratory period.*

*Prerequisites: BIO 201 and CHM 125.*

#### **BIO 415 Immunology (4 credits)**

An introductory course providing students with an overview of how the immune system works, including molecules, cells and organs of the immune system and their functions and interactions. Discussion of the experimental techniques used to understand the cell-cell interactions that occur in immunity as well as the differentiation and activation of the immune response will be included. *Two 50-minute lecture periods, one four-hour laboratory period.*

*Prerequisites: BIO 201 and CHM 125.*

#### **BIO 416 Microbiology (4 credits)**

The structural, cultural, and physiological characteristics of microorganisms and their role in the economy of nature. The principles of immunity, serology, and virology are also considered. *Three 50-minute lecture periods, one three-hour laboratory period.*

*Prerequisites: BIO 201 and CHM 125.*

#### **BIO 417 Systemic Physiology (4 credits)**

A study of the fundamental mechanisms of vertebrate physiology. The basis for the function of the various organ systems and the biological controls that result in the integration of these systems will be discussed. *Two 50-minute lecture periods, one four-hour laboratory period.*

*Prerequisites: BIO 201 and CHM 125.*

#### **BIO 419 Invertebrate Zoology (4 credits)**

A study of the morphology, physiology, behavior, and phylogenetic relationships of the major groups of invertebrates. Participants will compare and contrast the physical and biological challenges facing the invertebrates that live on land, in water, and inside other organisms. The laboratory will include observations and experiments on live and preserved animals. *Two 50-minute lecture periods, one four-hour lab period.*

*Prerequisites: BIO 201 and CHM 125.*

#### **BIO 420 Bioinformatics (4 credits)**

Introduction to the use of computers in biology. Students learn about important scientific questions and the contemporary tools used to answer them. Topics include genome sequence assembly and annotation, database mining, genome organization, phylogenetics and genetics of human disease. *Two 50-minute lecture periods, one four-hour lab period. Prerequisites: BIO 201 and CHM 125.*

#### **BIO 421 Molecular and Cellular Biophysics (4 credits)**

The course is designed to show students how the integration of physics, chemistry and molecular biology are used to explain and predict molecular and cellular processes such as protein-protein interactions, protein folding, diffusion, and signaling. The course will also provide students with a basic understanding and hands-on experience of several biophysical and biochemical laboratory techniques. *Two 50-minute lecture periods, one four-hour lab period. Prerequisites: BIO 201 and CHM 125.*

#### **BIO 422 Applied and Environmental Microbiology (4 credits)**

The course will introduce us to the complex relationships between microbes and their environment, including other organisms. In the frame of these relationships, we will explore how microbial activities are key to geochemical cycles and to human-engineered processes that are essential part of our lives. *Two 50-minute lecture periods, one four-hour lab period. Prerequisites: BIO 201 and CHM 125.*

#### **BIO 423 Evolution (4 credits)**

This course covers the major concepts of evolutionary biology, including natural selection, adaptation, genetic drift, and phylogenetic trees. The course trains students to know how to generate and test evolutionary hypotheses using data and inference. The lab portion of the course encourages hands-on learning through computer simulation and problem-solving. *Two 50-minute lecture periods, one four-hour lab period. Prerequisites: BIO 201 and CHM 125.*

#### **BIO 424 Biotechnology**

A course in which students will learn how basic cell and molecular biology are used to develop products for biomedical, agricultural and industrial applications. The course will also cover fundamental and emerging techniques in the biotechnology field. The lab section will focus on

the steps involved in the production and purification of recombinant proteins expressed in bacterial cells. *Two 50-minute lecture periods, one four-hour laboratory period. Prerequisites: BIO 201 and CHM 125.*

#### **BIO 425 Bacterial Pathogenesis (4 credits)**

A study of the physiological, genetic, and biochemical basis underlying some of the commonly encountered bacterial diseases. The course also addresses the roles of antimicrobial compounds and the host immune system in counteracting disease. Finally, in the lab module for the course, students perform discovery-oriented research as they identify novel genes in enteropathogenic *Escherichia coli* (EPEC) that affect bacterial virulence in a *C. elegans* (roundworm) model of disease. *Two 75-minute lecture periods, one three-hour laboratory period. Prerequisites: BIO 201 and CHM 125.*

#### **BIO 470 Special Topics in Biology (3 credits)**

Advanced study on a topic or problem to be arranged with any of the Departmental faculty members. *Open to juniors and seniors, with permission of the chair. Prerequisites: BIO 201 and CHM 125.*

#### **BIO 491-492 Biology Internship (3 credits)**

Internships enable the student to gain first-hand experience working in some field of biology. Interns should work a minimum of 10 hours weekly for 12 weeks to earn credit for a single course. Permission to take an internship for course credit must be obtained prior to beginning the internship. *Prerequisites: BIO 201 and CHM 125. Open to juniors and seniors, with permission of the chair of Biology.*

#### **BIO 493-494 Undergraduate Research (6 credits)**

Laboratory or field work on a specific biological problem in cooperation with a faculty member of the department. Normally requires three hours of work per week for each unit of credit. This course may be taken for credit multiple semesters but only one semester counts as a biology elective. In subsequent semesters this course will count as a general elective. *Students need to complete the application form for independent study (available in the Dean's Office) and have the approval of the department chair and Associate Dean. Prerequisites: BIO 201 and CHM 125.*

**BIO 493-494 Honors Research (6 credits)**

Laboratory work on a specific biological problem for either College Honors or University Honors. The student is expected to prepare and defend an Honors Thesis.. *Must be elected in junior year to allow adequate research time. Students need to complete the application form for independent study (available in the Dean's Office) and have the approval of the department chair, Associate Dean and the Honors Program Director. Prerequisites: BIO 201 and CHM 125.*