

BIOLOGY DEPARTMENT

FACULTY

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LEARNING GOALS:

- Biology majors will learn to identify and describe the basic principles and theories of the biological sciences.
- Using the basic principles and theories of the biological sciences, students will learn to construct and critique logical arguments in biology.
- Students will learn to use biological skills and techniques to acquire and evaluate scientific evidence.

BIOLOGY

Requirements for the Major in Biology. The Bachelor of Science degree in biology requires 60 semester hours in biology, chemistry and physics with grades of C- or better in biology. The Bachelor of Science degree includes an introductory sequence, biology distribution requirements (in cell and molecular biology, organismal biology, and ecology and evolution), and other requirements with an emphasis in research (Group A) or added academic instruction (Group B). In addition, all students must complete an experiential learning requirement.

16 Semester Hours – Introductory Sequence

4	BIOL-101 Ecology and Evolution
4	BIOL-102 Cell Biology and Genetics
4	BIOL-205 Organismal Biology
4	BIOL-220 Biostatistics or MATH-108 Introduction to Statistics or MATH-180 Statistical Methods

16 Semester Hours – Biology Distribution Requirements

Cell and Molecular Biology

Choose from one of the following:

3	BIOL-300 Developmental Biology
3	BIOL-306 Cell Biology
3	BIOL-316 Molecular Biology
3	BIOL-319 Advanced Genetics
3	BIOL-400 Immunology

Organismal Biology

Choose from one of the following:

- 3 BIOL-302 Comparative Vertebrate Anatomy
- 3 BIOL-310 Animal Physiology
- 3 BIOL-312 Microbiology
- 3 BIOL-320 Exercise and Extreme Physiology
- 3 BIOL-328 Natural History of Early Vertebrates
- 3 BIOL-404 Plant Physiology
- 3 BIOL-440 Behavioral Neuroendocrinology
- 3 BIOL-455 Functional Neuroanatomy
- 3 ECOL-110 Biogeodiversity

Ecology

Choose from one of the following:

- 3 BIOL-324 Animal Behavior
- 3 BIOL-326 Invertebrate Zoology
- 3 BIOL-332 Population Biology
- 3 BIOL-340 Marine Ecology
- 3 BIOL-408 Aquatic Ecology
- 3 BIOL-460 Winter Ecology of Vertebrates
- 3 ECOL-201 Community and Ecosystems Ecology

3 laboratory courses taken concurrently with lecture

4 Semester Hours – At least two different courses from:

- 2 BIOL-550 Explorations in Biology
- 2 BIOL-560 Interdisciplinary Explorations in Biology
- 2 BIOL-157 The Biology of Women
- 2 HLCR-370 Human Health and Disease
- 2 ECOL-560 Interdisciplinary Explorations in Ecology

Other Requirements: Based upon their qualifications and career goals, students may apply to be accepted in a collaborative research program (Group A), or they may elect to complete Group B.

Group A:

- 4 BIOL-510 Student Research I
- 4 BIOL-511 Student Research II

Group B:

- 4 BIOL-350 Investigative Problems in Biology
- 4 Biology elective courses at the 200 level or above

20 Semester Hours – Corollary Courses

- 4 General Chemistry I (choose from CHEM-101, CHEM-103 or CHEM-111)
- 4 CHEM-221 Organic Chemistry I
- 4 General Chemistry II (choose from CHEM-102, CHEM-104 or CHEM-232) or Organic Chemistry II (CHEM-222)
- 8 Choose 8 additional semester hours from the following courses:
Introductory Physics I (choose from PHYS-202, PHYS-203 or PHYS-204)

Introductory Physics II (choose from PHYS-205 or PHYS-206)
CHEM-222 Organic Chemistry II
CHEM-242 Methods of Chemical Analysis
CHEM-314 Survey of Biochemistry
CHEM-422 The Biochemistry of Nucleic Acids
CHEM-423 Biochemistry Nucleic Acids Laboratory
CHEM-424 The Biochemistry of Metabolism
CHEM-426 The Biochemistry of Proteins and Enzymes
CHEM-427 Biochemistry of Proteins and Enzymes Laboratory
CHEM-429 Biochemistry of Metabolism Laboratory
CHEM-311 Analytical Chemistry
CSCI-151 Introduction to Programming
CSCI-181 Principles of Computer Science
CSCI-301 Data Mining

Minor in Biology. Students minoring in biology complete 20 semester hours, including BIOL-101 Ecology and Evolution, BIOL-102 Cell Biology and Genetics, and BIOL-205 Organismal Biology. Students choose additional biology courses at the 200, 300 or 400 level. Although BIOL-500, BIOL-502, BIOL-550 and BIOL-560 may apply to the minor, other courses at the 500 level may not be taken for minor credit. At least one laboratory course is required in addition to BIOL-101, BIOL-102, and BIOL-205.

Honors in Biology. The departmental honors program encourages and recognizes superior academic performance in biology. To graduate with departmental honors, biology majors must request entry to the program or be nominated for entry to the program by a member of the biology faculty by the beginning of the senior year.

Candidates for academic honors must:

- Maintain a cumulative GPA of 3.25 and a GPA of 3.50 in biology courses to qualify for academic honors, and
- Successfully complete Student Research I and II (BIOL-510 and BIOL-511) and earn a grade of B- or better in these courses.

Candidates for research honors must:

- Be nominated by a member of the biology faculty by midterm of Student Research II (BIOL-511),
- Submit an acceptable research thesis based upon two semesters of Student Research (BIOL-510 and BIOL-511), and
- Pass an oral comprehensive examination of their thesis in their final semester.

Secondary Teaching Certification. Coursework required by the state of Pennsylvania for admission to the teacher certification program includes successful completion of ENGL-100 Writing and Thinking or equivalent course, at least 3 semester hours in British or American literature, at least 6 semester hours of mathematics coursework (or other courses which satisfy the Central Curriculum Analytical Thought requirement), and at least one 40-hour externship.

Education requirements for secondary education are EDUC-101 Introduction to Education and Society, EDUC-102 Historical and Philosophical Foundations of Education, EDUC-250 Educational Psychology, EDUC-260 Introduction to Special Education, EDUC-270 Instruction of Exceptional Students, EDUC-330 Technology in Education, EDUC-350 English Language Learners: Theory and Instruction, EDUC-380 Instructional Design, EDUC-424 Methods of Curriculum, Instruction, and Assessment in Teaching Science, EDUC-479 Principles of Learning and Teaching in Secondary Education, EDUC-483 Differentiated Instruction and Classroom Management in Secondary Education, and the EDUC-500 Student Teaching package (EDUC-501, EDUC-502, EDUC-503, and EDUC-600).

In addition, secondary education biology students complete all of the usual requirements for the biology major. When secondary education students satisfy the “choose 8 additional semester hours from the following courses” portion of the corollary course requirement, they must do so by taking Introductory Physics I (PHYS-202, 203 or 204) and Introductory Physics II (PHYS-205 or 206).

BIOMEDICAL SCIENCES

Requirements for the Major in Biomedical Sciences. The rigorous Biomedical Sciences major combines a solid foundation in the basic sciences of biology, chemistry, and physics with more applied courses related to the study of the human body plus the addition of courses in the social sciences that will prepare students for working effectively in the field of biomedicine as health care practitioners and biomedical researchers. This major allows students to meet the requirements for admission to medical and other professional programs and ensures they will have the necessary coursework to prepare for entrance exams such as the MCAT, DAT and OAT. Students completing this major will also be well prepared for admission to graduate study programs in biomedicine, such as cell and molecular biology, cancer biology, immunology, or microbiology, and to work in biomedical research settings. Students in the Biomedical Sciences major may not double-major or minor in Biology.

The Bachelor of Science degree in Biomedical Sciences requires 67-68 semester hours in the following courses, with grades of C- or better:

12 Semester Hours – Biology Sequence

- 4 BIOL-101 Ecology and Evolution
- 4 BIOL-102 Cell Biology and Genetics
- 4 BIOL-205 Organismal Biology

4 Semester Hours – Upper-level Cell/Molecular Biology with Laboratory

Take one of the following options:

- 4 BIOL-300/301 Developmental Biology
- 4 BIOL-306/307 Cell Biology
- 4 BIOL-312/313 Microbiology
- 4 BIOL-316/317 Molecular Biology
- 4 BIOL-319 Advanced Genetics
- 4 BIOL-400/401 Immunology

16 Semester Hours – Chemistry sequence

- 4 General Chemistry I (choose from: CHEM-101, CHEM-103 or CHEM-111)
- 4 CHEM-221 Organic Chemistry I
- 4 CHEM-222 Organic Chemistry II
- 4 General Chemistry II (choose from: CHEM-102, CHEM-104 or CHEM-232)

Biochemistry course

Take one of the following:

- 3-4 Choose from: CHEM-424 Biochemistry of Metabolism, CHEM-426 Biochemistry of Proteins and Enzymes or CHEM-314 Survey of Biochemistry

8 Semester Hours – Physics sequence (the course must be accompanied with the laboratory)

- 4 Introductory Physics I (choose from: PHYS-202, PHYS-203 or PHYS-204)
- 4 Introductory Physics II (choose from: PHYS-205 or PHYS-206)

4 Semester Hours – Physiology (the course must be accompanied with the laboratory when offered)

Take one course from the following:

- 4 HLCR-302 Human Physiology
- 4 BIOL-310/315 Animal Physiology
- 4 BIOL-320/315 Exercise and Extreme Physiology

12 Semester Hours – Additional required courses

- 4 HLCR-301 Human Anatomy
- 4 PSYC-101 Principles of Psychology
- 4 SOCI-101 Principles of Sociology or ANTH-162 Introduction to Anthropology

4 Semester Hours – Statistics

Take one course from the following:

- 4 BIOL-220 Biostatistics
- 4 MATH-108 Introduction to Statistics
- 4 MATH-180 Statistical Methods

4 Semester Hours – Capstone

- 4 BIOL-350 Investigative Problems in Biology

BIOLOGY COURSES

BIOL-010 Issues in Biology

Emphasizes analysis of biological problems relevant to the human experience and presents basic biological concepts in a variety of contexts. Subject matter might include medicine, environmental issues, ecology, molecular biology, physiology and others. 4 SH. 3 lecture hours. 3 laboratory hours. CC: Scientific Explanations. If the topic being offered is Spice of Life, the course is also Interdisciplinary and will have a pre-requisite of Junior Standing.

BIOL-101 Ecology and Evolution

Examination of descent with modification from a common ancestor, evidence for evolution, processes by which evolutionary changes occur, and how ecological interactions drive such changes. Course content will be linked to the five core concepts of biology (evolution; structure and function; information flow; energy transformations; and systems). Topics include the link between genotype and phenotype as it relates to natural selection and evolutionary change; mechanisms of microevolution; speciation processes; population growth and regulation; species interactions; and ecosystem structure and function. 4 SH. 3 lecture hours, 3 laboratory hours. CC: Scientific Explanations.

BIOL-102 Cell Biology and Genetics

Examination of life at the cellular level, focusing on the five core concepts of biology (evolution; structure and function; information flow; energy transformations; and systems). Topics include cell structure and function, protein structure and function as the link between genotype and phenotype, information flow from gene to protein, inheritance of traits in eukaryotic organisms, membrane structure and transport, energetics on the cellular level, cell cycle control and cancer. 4 SH. 3 lecture hours, 3 laboratory hours.

BIOL-157 The Biology of Women

Examines the genetic and biological basis of gender difference, the unique biology of the female body and women's health care issues. Topics include female reproductive anatomy and the menstrual cycle, pregnancy and birth, developmental differences in the sexes, and reproductive technologies. Also covers problems such as breast cancer, premenstrual syndrome and osteoporosis. Includes the role of women in the health care system, as well as biology and science in general. Same as WGST-250. Prerequisite: Sophomore standing. 4 SH. CC: Diversity Intensive, Interdisciplinary.

BIOL-205 Organismal Biology

Organismal Biology will focus on the level of the organism as the biological scale through which to build the student's understanding of five core concepts in biology: evolution, information flow, structure-function relationships, energy transformations and systems biology. This course is designed as an introductory course, meaning that it introduces fundamental concepts that will be elaborated on and reinforced at a more sophisticated and deeper level in the more advanced courses that are taken as distribution requirements in the junior and senior year. Prerequisites: BIOL-101 and BIOL-102 or permission of the instructor. 4 SH.

BIOL-220 Biostatistics

Biostatistics will focus on the collection and analysis of biological data. The course is designed to introduce students to the fundamental concepts of experimental and sampling design, as well as quantitative hypothesis testing. Some equations will be covered in the course; however, the emphasis will be on interpretation and presentation of statistical results. These concepts will be reinforced in upper-level biology/ecology/neuroscience courses taken by students to fulfill distribution requirements during their junior and senior years. Same as BIOL-220. Prerequisites: Sophomore standing and either BIOL-101, BIOL-102, or ECOL-100. 4 SH. 4 lecture hours. CC: Analytical Thought.

BIOL-225 Organismal Form and Function

This course serves as an introduction to the systems of the body, including basic study of structure and function. Topics include an introduction to homeostasis, cells and tissues, as well as basic functions of the cardiovascular, respiratory, nervous, endocrine, digestive, urinary and reproductive systems. Upon completion, students should be able to demonstrate a basic understanding of the fundamental principles of anatomy and physiology and their interrelationships. Pre-requisites: BIOL-102. 4 SH.

BIOL-250 STEM First-Year Seminar

This seminar is taken by students in the STEM Scholars' Program in the spring of their first year as a way of continuing to work together to build the STEM cohort, learn about STEM careers, and explore their own interests and aptitudes regarding future career options. Not for major or minor credit. Prerequisite: Instructor permission required. 0.5-1 SH.

BIOL-300 Developmental Biology

Examines embryo development, focusing on cellular and regulatory mechanisms that guide the process. Topics include the events of development from fertilization through organogenesis in a range of animal systems from sea urchins through mammals. Prerequisite: BIOL-102. 3 SH. CC: Ethics Intensive.

BIOL-301 Developmental Biology Laboratory

An investigative approach to the study of animal development, emphasizing cellular and molecular techniques. Students work in small groups to conduct and analyze self-designed experiments with invertebrate embryos. Prerequisite: BIOL-102. 1 SH. 3 laboratory hours. CC: Ethics Intensive.

BIOL-302 Comparative Vertebrate Anatomy

Examines the evolutionary relationships among the vertebrate classes, using comparative morphological evidence. Uses an organ system approach to the study of anatomy and considers unique adaptations of individual vertebrates. Prerequisite: BIOL-205. 3 SH.

BIOL-303 Comparative Vertebrate Anatomy Laboratory

Organ-based study of representative vertebrates, including shark and cat dissections. Laboratory may not be taken without BIOL-302. Prerequisite: BIOL-205. 1 SH. 3 laboratory hours.

BIOL-306 Cell Biology

Examines the molecular aspects of cell structure and function and the molecular processes that regulate cell behavior. Emphasizes experimental and problem-based approaches, and includes information on the cell biology of human disease. Prerequisite: BIOL-102. 3 SH.

BIOL-307 Cell Biology Laboratory

Introduces the laboratory techniques commonly used in the study of cell biology. Includes labs on the isolation and characterization of proteins and nucleic acids. Laboratory may not be taken without BIOL-306. Prerequisite: BIOL-102. 1 SH. 3 laboratory hours.

BIOL-310 Animal Physiology

General and comparative physiology. Emphasizes membrane, neural, muscular and homeostatic physiology. Prerequisite: BIOL-205 and junior standing. 3 SH.

BIOL-312 Microbiology

An introduction to the morphology, physiology and genetics of microorganisms. Discusses the roles of microorganisms in the environment and in human disease. Prerequisite: BIOL-205 or ECOL-201. 3 SH.

BIOL-313 Microbiology Laboratory

Emphasizes basic bacteriologic techniques, including staining, culturing and identification. Laboratory may not be taken without BIOL-312. Prerequisite: BIOL-205 or ECOL-201. 1 SH. 3 laboratory hours.

BIOL-315 Animal and Exercise Physiology Lab

A laboratory in general animal and human exercise physiology. Investigates the physiological basis of responses to exercise and extreme environments with an emphasis on neural, muscular, respiratory and cardiovascular mechanisms. Uses some animal models. Laboratory may not be taken without either BIOL-310 or BIOL-320. Prerequisite: BIOL-205 and junior standing. 1 SH. 3 laboratory hours.

BIOL-316 Molecular Biology

Examines the structure and function of DNA and RNA of prokaryotes and eukaryotes. Topics include recombinant DNA technology, genomics and bioinformatics. Prerequisite: BIOL-102. CHEM-221 strongly recommended. 3 SH.

BIOL-317 Molecular Biology Laboratory

Investigates the structure and function of DNA through techniques of molecular biology. Topics include agarose gel electrophoresis, DNA hybridization and gene cloning. Laboratory may not be taken without BIOL-316. Prerequisite: BIOL-102. 1 SH. 3 laboratory hours.

BIOL-319 Advanced Genetics

This workshop-style course will explore advanced topics in the expression, evolution and inheritance of genetic material, as well as the modern techniques that are used in their analysis. It will also consider the ethical issues that arise from the generation and potential uses of the resulting knowledge. It will build upon the basic molecular and Mendelian genetics concepts taught at the introductory level. Prerequisite: BIOL-102 or permission of instructor. 4 SH. 3 lecture hours. 1 laboratory hour. CC: Ethics Intensive.

BIOL-320 Exercise and Extreme Physiology

A study of physiological processes in humans related to exercise and participation in sports. This course also examines the effects and repercussions of exposure of the human body to extreme environments, such as those experienced by scuba divers, climbers and high-altitude pilots. Prerequisite: BIOL-205 and junior standing. 3 SH.

BIOL-324 Animal Behavior

Explores the adaptive value of animal behavior with an emphasis on theory and hypothesis testing using examples drawn from primary literature. Major topics include sexual selection, mating systems, parental care, sociality, foraging theory, antipredator behavior, game theory and communication framed within an evolutionary context. Prerequisite: BIOL-101 or ECOL-100. 3 SH.

BIOL-325 Animal Behavior Laboratory

Field and laboratory techniques in behavioral data collection, experimental design and statistical analysis. Hypothesis development and testing emphasized. A portion of the grade is based on an independent research project. Laboratory may not be taken without BIOL-324. Prerequisite: BIOL-101 or ECOL-100. 1 SH. 3 laboratory hours.

BIOL-326 Invertebrate Zoology

An introduction to evolutionary themes and functional approaches to invertebrate animal biology. Course covers a broad survey of the invertebrate phyla. Within the coverage of each group, unique aspects of morphology, physiology, ecology and behavior are discussed in light of the selective forces that have favored their evolution. Prerequisite: BIOL-304, or ECOL-110, or BIOL-205, or ECOL-201. 3 SH.

BIOL-327 Invertebrate Zoology Laboratory

An introduction to invertebrate phyla and subgroups with emphasis on form and functional morphology, organ systems, life history, ecology and behavior. Course includes dissections, examination of preserved material, demonstrations and observations of living animals. In addition, students organize an invertebrate collection based on local fauna. Laboratory may not be taken without BIOL-326. Prerequisite: BIOL-304, or ECOL-110, or BIOL-205, or ECOL-201. 1 SH. 3 laboratory hours.

BIOL-328 Natural History of Early Vertebrates

This course will focus on early vertebrates' life history with great emphasis on systematics, evolution, phylogeny, morphology, reproduction, development and zoogeography. Plate tectonics and paleontology will have a pivotal role in explaining patterns and processes in the natural history of this unique subset of vertebrates, otherwise known as "Ichthyoids." This upper-level biology/ecology course is designed to be taken by students to fulfill distribution requirements during their sophomore, junior and/or senior years. Prerequisite: BIOL-304, or ECOL-110, or BIOL-205, or ECOL-201. 3 SH. 3 lecture hours.

BIOL-329 Natural History of Early Vertebrates Laboratory

This course will be an examination of patterns and processes in the natural history of this unique subset of vertebrates, otherwise known as "Ichthyoids." Through the different laboratories students will be introduced to field and laboratory methodologies of identifying Pennsylvania early vertebrates, specimen handling, collecting techniques, dissection, preparation, and field sign recognition. This upper-level biology/ecology course is designed to be taken by students to fulfill distribution requirements during their sophomore, junior and/or senior years. Laboratory may not be taken without BIOL-328. Prerequisite: BIOL-304, or ECOL-110, or BIOL-205, or ECOL-201. 1 SH. 3 laboratory hours.

BIOL-332 Population Biology

This course will introduce students to the biotic and abiotic factors that influence the size and trajectory of populations. Topics of the course will include understanding demographic rates, density independent and density dependent population growth rates, density, population dynamics of structured and non-structures populations, competitions, and predation. Prerequisite: BIOL-101 or ECOL-100. 3 SH.

BIOL-333 Population Biology Laboratory

This course will introduce students to methods used in estimating demographic rates and population parameters, such as age structure. Concepts fundamental to experimental design and statistical analysis of data will be stressed. Laboratory cannot be taken without BIOL-332. Prerequisite: BIOL-101 or ECOL-100. 1 SH. 3 laboratory hours.

BIOL-340 Marine Ecology

This course provides an examination of the ecology of marine and estuarine systems based on the principles of population biology and community ecology. Studies the ecology of the major marine communities: rocky intertidal and subtidal substrate, mangroves, salt marshes, kelp, soft substrate, estuarine, plankton, coral reef and deep sea. Emphasis is placed on current hypotheses concerning the processes controlling the distribution and abundance of organisms in these communities and critical evaluation of the primary scientific literature. Prerequisites: ECOL-201, or BIOL-205, or EENV-220. 3SH.

BIOL-341 Marine Ecology Laboratory

This course is a 9 day field course where we compare marine ecosystems in the Bahamas or other locations investigating their structure and function. During the field days, we sample different parts of the ecosystems (the pelagic system, coral reefs, mangroves, and hard- and soft benthic communities and their associated fauna and fish communities). Field work is performed as group projects that have been planned and designed in advance by the students. Prerequisites: BIOL-340 and either ECOL-201, BIOL-205, or EENV-220. 1 SH

BIOL-350 Investigative Problems in Biology

Offered for a capstone experience for biology majors in Group B. Provides an authentic research experience based in the area of expertise of the supervising faculty. Students will learn important laboratory and/or field approaches to collect novel data in order to answer research questions. Course elements include experimental design, data collection and analysis, and presentation in oral and written formats. Prerequisites: Senior standing, BIOL-205, and either BIOL-220 or MATH-108 or MATH-180 or permission of the instructor. 4 SH. Capstone. CC: Writing Intensive.

BIOL-400 Immunology

Investigates how the immune system defends vertebrate organisms against invasion by pathogenic microorganisms. Discusses recognition of antigens and interactions between components of the immune system from a molecular perspective. Prerequisite: BIOL-102. 3 SH.

BIOL-401 Immunology Laboratory

Techniques used in immunological studies. Topics include antibody purification, immunofluorescence and Western blot analysis. Laboratory cannot be taken without BIOL-400. Prerequisite: BIOL-102. 1 SH. 3 laboratory hours.

BIOL-404 Plant Physiology

The physiology of photosynthetic organisms. Includes photosynthesis, translocation, metabolism, mineral nutrition, photoperiodism, hormones, growth and development. Prerequisite: BIOL-205 or ECOL-201. 3 SH.

BIOL-405 Plant Physiology Laboratory

A series of experiments designed to illustrate the unique physiology of photosynthetic organisms. Laboratory may not be taken without BIOL-404. Prerequisite: BIOL-205 or ECOL-201. 1 SH. 3 laboratory hours.

BIOL-408 Aquatic Ecology

The ecology of freshwater ecosystems. Emphasizes biota of freshwater and their relationships with physical and chemical components of lakes, streams and reservoirs. Same as ECOL-408. Prerequisite: BIOL-101 or ECOL-100 or ECOL-201. 3 SH.

BIOL-409 Aquatic Ecology Laboratory

Field laboratory in aquatic ecology techniques. Topics include physical and chemical measurements and the identification and enumeration of phytoplankton, zooplankton, aquatic plants and benthic organisms. Same as ECOL-409. Laboratory may not be taken without BIOL-408 (or ECOL-408). Prerequisite: BIOL-101 or ECOL-100, or ECOL-201. 1 SH. 4 laboratory hours.

BIOL-440 Behavioral Neuroendocrinology

This course deals with the interrelationships among hormones, the brain and behavior. The role of the nervous system and hormones in the development and regulation of behavior, as well as how experience can regulate neuroendocrine physiology, will be examined. This course puts special emphasis on generating and testing hypotheses based on knowledge gained from reviewing the primary literature. Specific topics covered include the endocrine regulation of reproductive behavior, aggressive behavior, biological rhythms, energy balance, stress, learning and memory. Prerequisite: BIOL-205. Corequisite: BIOL-441. 3 SH. CC: Writing Intensive.

BIOL-441 Behavioral Neuroendocrinology Laboratory

This course investigates the experimental methodology used by behavioral neuroendocrinologists to investigate the interrelationships among hormones, the brain and behavior. The course provides hands-on learning about laboratory techniques that examine neuropeptides, hormones, brain structures and behavior, as well as proper use of animals in research, experimental design and statistical analysis. Hypothesis development and testing is emphasized, and a portion of the grade is based on an independent research project. Prerequisite: BIOL-205. Corequisite: BIOL-440. 1 SH. 3 laboratory hours. CC: Writing Intensive.

BIOL-450 Advanced STEM Seminar

This seminar is taken by students in the STEM Scholars' Program in the second, third and fourth years as a way of continuing to work together to build the STEM cohort, learn about STEM careers, and explore their own interests and aptitudes regarding future career options. Not for major or minor credit. Prerequisite: BIOL-250. 0.5 SH.

BIOL-455 Functional Neuroanatomy

This course is a detailed look at the sophisticated cellular and molecular mechanisms in the nervous system and how these mechanisms provide the foundation for circuits and functional neuroanatomical structures capable of generating complex behaviors and physiological functions. This course connects functional cellular and anatomical units of the nervous system to behaviors typically addressed by the field of psychology, such as learning, motivation, addiction and psychological disorders. The initial material focuses on the molecular structure and function of neurons and then builds upon this foundation by progressively assembling the functional neuroanatomical structures of the nervous system and considering the complex behaviors that these structures generate. Prerequisites: BIOL- 102, PSYC-101 and junior standing or instructor's permission. 4 SH. 3 lecture hours, 3 laboratory hours. CC: Interdisciplinary.

BIOL-460 Winter Ecology of Vertebrates

This course will survey all amniote vertebrates and their winter adaptations. It will focus on physiological ecology, evolution, morphology, reproduction and development of reptiles, birds and mammals. This upper-level biology/ecology course is designed to be taken by students to fulfill distribution requirements during their sophomore, junior and/or senior years. Prerequisite: BIOL-101 or ECOL-100. 3 SH. 3 lecture hours.

BIOL-461 Winter Ecology of Vertebrates Laboratory

This course will survey all amniote vertebrates and their winter adaptations. Through the different laboratories students will be introduced to field and laboratory methodologies of identifying Pennsylvania early vertebrates, specimen handling, collecting techniques, dissection, preparation and field sign recognition. This upper-level biology/ecology course is designed to be taken by students to fulfill distribution requirements during their sophomore, junior and/or senior years. Laboratory may not be taken without BIOL-460. Prerequisite: BIOL-101 or ECOL-100. 1 SH. 3 laboratory hours.

BIOL-500 Topics in Biology

Varying topics of interest to students and instructor. Possible topics include genetic engineering advances in embryology, plant products, reproductive physiology and stress ecology. Prerequisites: Prior course in general topic area and instructor's permission. Variable credit.

BIOL-501 Seminar in Biology

Weekly one-hour meetings in which students and staff report and discuss current biological research literature. Senior biology majors in Group B track require one semester. 2 SH. Capstone.

BIOL-502 Biology Internship

Career investigation for junior and senior biology majors. May be repeated once. A written report of the internship will be required. Prerequisite: First two years of the biology major program. 1 SH. Minimum of 5 contact hours.

BIOL-504 Independent Study in Biology

Investigation of a specific topic or problem in biology under the guidance of an appropriate faculty member. 1-4 SH.

BIOL-510 Student Research I

Introduces students to methods and techniques of biological research in the context of a collaborative research project. Required for students in the Group A track. Prerequisite: Instructor's permission. 4 SH. 16 contact hours. Capstone.

BIOL-511 Student Research II

Collaborative research with an emphasis on presentation of data and explanation of results. Required for students in the Group A track. Prerequisite: Instructor's permission. 4 SH. 16 contact hours. Capstone. CC: Writing Intensive.

BIOL-550 Explorations in Biology

Explores salient issues in the biological sciences. Prerequisites: BIOL-101 or BIOL-102, junior standing or instructor's permission. 2-4 SH.

BIOL-560 Interdisciplinary Explorations in Biology

Explores salient issues in the biological sciences from an interdisciplinary perspective. Prerequisites: Sophomore standing and BIOL-101, BIOL-102, or ECOL-100. 2-4 SH. CC: Interdisciplinary.