

BIOLOGY

The Department of Biology offers baccalaureate degrees in biology (BIOL) and allied health (ALTH), with 11 options in the BIOL program and 5 options in the ALHT program. The requirements are very similar for the BS BIOL programs during the first two years, so any change in career emphasis need not involve any major loss of time or credits. The department also offers minors in biology and molecular biology/biotechnology.

The program leading to the Bachelor of Science degree provides students with an opportunity to elect a substantial number of courses in a specific area of biology. This program provides a strong background for admission to graduate or professional school and prepares the student for employment in the field of biology upon graduation.

Options available within the B.S. Biology program include animal behavior, environmental biology, marine biology, molecular biology/biotechnology, medical technology, nuclear medicine technology, plant sciences, premedical professions, pre-optometry, pre-podiatry and respiratory therapy.

The **animal behavior** option provides training in both the biological mechanisms and the evolutionary functions of behavior. Students completing this option are prepared for a career in applied animal behavior or for graduate study.

The **environmental biology** option permits students to concentrate in ecology and enables them to gain expertise that will make them competitive in industry, governmental agencies and graduate school.

The **marine biology** option encourages students to choose electives in the marine biology area. Many marine science courses are offered at our field station at Wallops Island, Virginia, since they usually involve significant field work. For more information on the field station, see "Chincoteague Bay Field Station at the Marine Science Consortium": <http://www.cbfieldstation.org/> (<http://www.cbfieldstation.org/>)

The **molecular biology/biotechnology** option allows students to concentrate in genetics, cell and molecular biology. The courses required for this option complement each other, training students in a variety of laboratory and methods and enabling students to gain the theoretical understanding and technical expertise currently needed to be competitive in industry and graduate school.

Students in the **plant sciences** option concentrate on the study of plants while obtaining a broad background in biology. This option effectively prepares those interested in professions in general botany, environmental studies, molecular/biotech, and horticulture as well as advanced graduate study in a variety of plant-related fields.

The **pre-medical professions** option allows the students to focus on courses in anatomy, physiology, cell biology and genetics. It includes one track for students planning on continuing their education in medical, dental or physician assistant school and another for students preparing for veterinary school. The program provides a strong background in courses that prepare the students for taking the appropriate entrance exams and encourages them to take advanced courses that will help them succeed in those professional programs.

Millersville University has an Early Acceptance Program (EAP) agreement with the Lake Erie College of Osteopathic Medicine (LECOM) for programs

in osteopathic medicine, dentistry and pharmacy. The current agreement is a "4+4 year program" and is designed for incoming first year students and second-year students. Students who are interested in the EAP must be accepted by LECOM, either as an incoming first year student, or before completing their sophomore year, and complete their degree at Millersville University. (EAP students will need to take the MCAT and complete an online application before they can enroll at LECOM.) Accepted students must do well during each academic semester at Millersville but will have a guaranteed seat in the classroom at LECOM.

After completing three years of undergraduate study, students in the **medical technology (clinical/medical laboratory science)** program are eligible to apply to an accredited hospital-based medical technology program for one year of clinical laboratory experience, after which they will be awarded the Bachelor of Science degree and will be eligible to sit for the national certification examination. Currently, Millersville has full affiliations with three hospital-based programs (PA College of Health Sciences, York Hospital, Reading Hospital) and a renewable affiliation with Penn State Hershey.

After completing three years of undergraduate study, students in the **nuclear medicine technology** program are eligible to apply for admission to either the Pennsylvania College of Health Sciences of Nuclear Medicine Technology program (12-month clinical phase) or the Johns Hopkins School of Imaging program (18-month clinical phase), after which they will be awarded the Bachelor of Science degree and will be eligible to sit for the national certification examination.

An agreement between Millersville University and Salus University (formerly the Pennsylvania College of Optometry) in Philadelphia allows students in the **pre-optometry** option to complete three years of undergraduate study at Millersville and then transfer to Philadelphia for the first year of study in the doctoral program. Students who complete the year with good grades receive a B.S. in Biology from Millersville University, and after three additional years earn the Doctor of Optometry degree.

A cooperative option exists between Millersville University and the Temple University School of Podiatric Medicine. This 3/4 **pre-podiatry** program allows students to transfer to the professional school after satisfactorily completing 99 semester hours at Millersville University. After successful completion of the basic science courses at the Temple University School of Podiatric Medicine, students are awarded a B.S. in biology from Millersville University. Three recommended Millersville students a year have reserved spaces for admission to the podiatric college, where graduation after four years earns a D.P.M. degree.

Millersville University is the sponsoring institution for the **respiratory therapy** program. After successfully completing three years of study at Millersville, students enter the 16-month clinical phase at Millersville University and UPMC Lititz. Admission into the clinical phase is competitive and not guaranteed. At the end of the clinical phase, they are awarded the Bachelor of Science degree and a certificate in respiratory therapy, and will be eligible to sit for the national credentialing examination.

The education curriculum leads to the **Bachelor of Science in Education**, with secondary education certification in biology.

Bachelor of Science in Allied Health Technology

The Department of Biology offers one degree and five options leading to the baccalaureate degree in allied health technology. The requirements

are initially very similar for each of the options so that any change in career emphasis need not involve any major loss of time or credits.

A dual-degree program in **pre-athletic training** is available for well-prepared students. During three years of study at Millersville, students complete the requirements for admission to an affiliated graduate program. Upon completion of one year of graduate study, credits transfer back to Millersville to satisfy the requirements for the B.S. degree in allied health technology, pre-athletic training. Students then earn a M.S. in athletic training from the affiliated university after a second year of graduate study.

A four-year program prepares students for graduate or professional studies to become specialists in **sports medicine**, such as athletic trainers, physical therapists, physicians and physician assistants. The curriculum includes courses in nutrition, sports psychology, and the prevention and care of injuries.

After completing three years of undergraduate study, students in the **allied health technology/medical technology (clinical/medical laboratory science)** program are eligible to apply to an accredited hospital-based medical technology program for one year of clinical laboratory experience, after which they will be awarded the Bachelor of Science degree and will be eligible to sit for the national certification examination. Currently, Millersville University has full affiliations with three hospital-based programs (PA College of Health Sciences, York Hospital, Reading Hospital) and a renewable affiliation with Penn State Hershey.

After completing three years of undergraduate study, students in the allied health technology/**nuclear medicine technology** program are eligible to apply for admission to either the Pennsylvania College of Health Sciences (12-month clinical phase) program or the Johns Hopkins School of Imaging (18-month clinical phase) program, after which they will be awarded the Bachelor of Science degree and will be eligible to sit for the national certification examination.

Millersville University is the sponsoring institution for the **respiratory therapy** program. After successfully completing two years of study at Millersville University, students enter the approximately two-year clinical phase at UPMC Lititz. Admission into the clinical phase is competitive and not guaranteed. At the end of the clinical phase, students are awarded the Bachelor of Science degree and a certificate in respiratory therapy, and will be eligible to sit for the national credentialing examination. This degree option differs from the other B.S. allied health technology and B.S. degree programs offered by the biology department in its format and is termed a "2+2 year program" that begins the clinical year in the summer following the sophomore year, not the end of the junior year, as is the case for the other degree options.

the programs

- Allied Health Technology, B.S. - Pre-Athletic Training Dual-Degree Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/allied-health-technology-bs-pre-athletic-training-dual-degree-option/>)
- Allied Health Technology, B.S. - Respiratory Therapy 2+2 Year Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/allied-health-technology-bs-respiratory-therapy-2-2-year-option/>)
- Allied Health Technology, B.S. - Medical Technology 3+1 Year Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/allied-health-technology-bs-medical-technology-3-1-year-option/>)

- Allied Health Technology, B.S. - Nuclear Medicine Technology 3+1 Year Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/allied-health-technology-bs-nuclear-medicine-technology-3-1-year-option/>)
- Allied Health Technology, B.S. - Sports Medicine (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/allied-health-technology-bs-sports-medicine/>)
- Biology Minor (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/biology-minor/>)
- Biology, B.S. (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/biology-bs/>)
- Biology, B.S. - Environmental Biology Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/biology-bs-environmental-biology-option/>)
- Biology, B.S. - Respiratory Therapy Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/biology-bs-respiratory-therapy-option/>)
- Biology, B.S. - Animal Behavior Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/biology-bs-animal-behavior-option/>)
- Biology, B.S. - Marine Biology Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/biology-bs-marine-biology-option/>)
- Biology, B.S. - Medical Technology Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/biology-bs-medical-technology-option/>)
- Biology, B.S. - Molecular Biology/Biotechnology Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/biology-bs-molecular-biology-biotechnology-option/>)
- Biology, B.S. - Nuclear Medicine Technology Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/biology-bs-nuclear-medicine-technology-option/>)
- Biology, B.S. - Optometry Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/biology-bs-optometry-option/>)
- Biology, B.S. - Plant Sciences Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/biology-bs-plant-sciences-option/>)
- Biology, B.S. - Pre-Medical Professions Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/biology-bs-pre-medical-professions-option/>)
- Biology, B.S. - Pre-Podiatry Option (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/biology-bs-pre-podiatry-option/>)
- Biology, B.S.Ed. (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/biology-bs-ed/>)
- Molecular Biology/Biotechnology Minor (<https://catalog.millersville.edu/undergraduate/college-science-technology/biology/molecular-biology-biotechnology-minor/>)

the faculty

Cebra-Thomas, Judith; Associate Professor
College of Science and Technology
B.A., Johns Hopkins University, 1979; Ph.D., Washington University, 1986

Didier, Dominique; Professor
College of Science and Technology

B.A., Illinois Wesleyan University, 1987; Ph.D., University of Massachusetts, 1992

Fellmeth, Jessica; Assistant Professor

College of Science and Technology

B.A., The College of New Jersey, 2006; Ph.D., Rutgers the State University of New Jersey, 2015

Haines, Aaron; Professor

College of Science and Technology

B.S., Virginia Tech, 1998; M.S., Texas A&M University, 2003; Ph.D., Ibid., 2006

Hardy, Christopher; Professor

College of Science and Technology

A.A., Catonsville Community College, 1991; B.S., University of Maryland, 1995; Ph.D., Cornell University and New York Botanical Garden, 2001

Hoover, John; Professor

College of Science and Technology

B.S., Indiana University of Pennsylvania, 1985; Ph.D., SUNY at Syracuse, 1990

Horton, Brent; Associate Professor

College of Science and Technology

B.S., Warner College of Natural Resources, 1999; Ph.D., University of Maine, 2007

Klosinska, Maja; Associate Professor

College of Science and Technology

M.S., University of Lodz (Poland), 2003; M.S., Ibid., 2004; Ph.D., Princeton University, 2011

Lehman, Heather; Associate Professor

College of Science and Technology

B.S., Shippensburg University, 2004; Ph.D., University of Delaware, 2012

Ligocki, Isaac; Assistant Professor

College of Science and Technology

B.A., Wittenberg University, 2006; Ph.D., The Ohio State University, 2015

Ramos-Sepulveda, Laura; Assistant Professor

College of Science and Technology

B.A., University of Puerto Rico at Mayaguez, 2010; Ph.D., The Pennsylvania State University, 2014

Ryndock, Eric; Assistant Professor

College of Science and Technology

B.S., Millersville University, 2007; Ph.D., The Pennsylvania State University, College of Medicine, 2016

Stieha, Christopher; Associate Professor

College of Science and Technology

B.S., University of Kentucky, 2003; B.A., Ibid., 2003; M.S., Ibid., 2008; Ph.D., Ibid., 2012

Wagner, Ryan; Professor

College of Science and Technology

B.S., South Dakota State University, 1996; Ph.D., Washington State University, 2001

Weaver, Carolyn; Assistant Professor

College of Science and Technology

B.S., Texas A&M University at Galveston, 2003; Ph.D., Ibid., 2016

Weise Cross, Laura; Assistant Professor

College of Science and Technology

B.A., University of Texas, 2009; B.S., Ibid., 2009; Ph.D., University of North Carolina, 2015

the courses

BIOL 100: 3 s.h.

General Biology (G2)

An introduction to biology with emphasis on cell structure, metabolism, genetics, behavior, ecology, adaptations, organ systems and evolution. 2 hours lec., 2 hours lab. No credit toward BIOL major.

BIOL 101: 4 s.h.

Foundations of Biology (G2)

This introduction of biological principles provides the foundation of modern biological knowledge essential for all higher-level courses. Topics include cell structure and function, cellular reproduction, energy acquisition, biochemical pathways, mechanisms of inheritance, natural selection, speciation and evolution. 2 hrs. lec., 1 hr. discussion, 3 hrs. lab. Offered in fall, spring. Prereq: Biology major or biology minor or permission of instructor.

BIOL 108H: 1 s.h.

Hnrs:Freshman Biology Seminar

Emphasis on the intellectual and historical context of the core ideas of BIOL 100 and an in-depth exploration of ideas raised in lecture and laboratory. Satisfies the honors lab when taken with Biology 100. 1 hr. seminar. Offered in fall, spring. Prereq or coreq: BIOL 100 or 101.

BIOL 140: 3 s.h.

Introductory Ecology (G2)

Introductory course in ecology (interactions of living organisms with the environment), evolution (adaptations of living organisms to the environment) and the environment of life on planet Earth. Important applied ecological topics such as agriculture and forestry, exploitation of populations, effects of disturbance and climate change, and conservation of biological diversity also are examined. The course covers significant content of the Academic Standards for Environment and Ecology and the Middle-Level Science Competencies as required by the Pa. Dept. of Education. 2 hrs. lec., 2 hrs. lab. No credit toward BIOL major. Prereq: ENGL 110, COMM 100 and completion of one course of MATH (101 or higher) or MPT of 160. In addition, BIOL 100 or 101 is recommended but not required. Offered during spring semester.

BIOL 179: 3 s.h.

Experimental

Experimental

BIOL 204: 3 s.h.

Human Biology (G2, W)

A non-laboratory course in human biology designed specifically for those students planning to specialize in social work, psychology or related fields. An overview of the changes that take place in the course of a human lifetime; basics of human evolution, ecology, behavior, anatomy and physiology of the human organism are discussed. 3 hrs. lec. Offered fall, spring. Prereq: BIOL 100 or BIOL 101, or permission of instructor, and ENGL 110. No credit toward BIOL major.

BIOL 205: 3 s.h.

Heredity and Human Affairs (G2)

Genetics for non-majors with reference to human heredity and development. The social implications of recent advances in genetics are considered. 3 hrs. lec. Offered periodically. Prereq: BIOL 100 or BIOL 101, or permission of instructor or RN, and MATH 1**. No credit toward BIOL major.

BIOL 207: 3 s.h.**Human Sexuality (D, G2, W)**

Study of the nature of human sexuality, particularly as it relates to biological phenomena. Discussions and lectures will cover the biology of human reproduction, biology of human sexual behavior and its implications. 3 hrs. lec. Offered periodically. Prereq: BIOL 100 or BIOL 101, or permission of instructor or RN, and ENGL 110. No credit toward BIOL major.

BIOL 207H: 3 s.h.**Hon: Human Sexuality (D, G2, W)****BIOL 208: 3 s.h.****Plants and People (G2)**

Explores uses of plants and plant products by man and their impact on the development of civilization. Characteristics of plants that make them suitable for food, shelter, clothing, energy, medicines, entertainment, objects of worship, microclimate modification, and aesthetic objects are discussed. 3 hrs. lec. Offered periodically. Prereq: BIOL 100 or BIOL 101, or permission of instructor. No credit toward BIOL major.

BIOL 211: 4 s.h.**Concepts of Zoology (G2)**

Study of invertebrate and vertebrate animals. Classification, reproduction, development, ecology, physiology, behavior, genetics, scientific methodology (including simple statistical approaches), and evolution. Laboratory studies include microscopy, dissections, live observations, computer exercises and experimentation. 3 hrs. lec., 3 hrs. lab. Prereq: BIOL 101 or BIOL 100 with a grade of C- or higher for non-majors; B- or higher in BIOL 100 for biology majors.

BIOL 212H: 1 s.h.**Hnrs:Zoology Seminar**

Continuation of BIOL 211. Original investigations and/or readings and discussions of the zoological literature about the diverse adaptations of animals to their environments. Completion of both BIOL/HNRS 212 and BIOL 211 earns 5 credits to be counted as one course in the G2 block. BIOL/HNRS 212 may not be used independently to fulfill a G2 requirement. 1 hr. seminar. Offered periodically. Prereq: completion of BIOL 211 with a grade of B- or higher and member of University Honors College, or 3.35 GPA, or instructor's permission.

BIOL 221: 4 s.h.**Concepts of Botany (G2)**

Consideration of features unique to plants such as localized meristems and open growth, water relations, photosynthesis, and cell structure. An integrated study of plant structure and function using angiosperms as principal examples. Includes brief discussions of plant and fungal diversity, plant ecology and evolution and economic botany. 3 hrs. lec., 3 hrs. lab. Prereq: BIOL 101 or BIOL 100 with a grade of C- or higher; B- or higher in BIOL 100 for biology majors.

BIOL 222H: 1 s.h.**Hnrs:Problem Solving In Botany**

A botanical science investigation of a problem or series of problems. Students define a problem with a botanical basis, search appropriate literature, formulate hypotheses and collect appropriate information to test hypotheses through experimentation and data gathering. Completion of both BIOL/ HNRS 222 and BIOL 221 earns 5 credits to be counted as one course in the G2 block. BIOL/HNRS 222 may not be used independently to fulfill a G2 requirement. 1 hr. seminar. Offered periodically. Prereq: completion of BIOL 221 with a grade of B- or higher and member University Honors College, or 3.35 GPA, or instructor's permission.

BIOL 254: 4 s.h.**Human Anatomy & Physiology I**

Study of the structure and function of the human body. This first semester of a two-semester sequence deals with the development, histology, gross anatomy, function and pathophysiology of the cutaneous, skeletal, muscular and nervous systems. 3 hrs. lec., 3 hrs. lab. Prereq: BIOL 100 or BIOL 101.

BIOL 254H: 4 s.h.**Hon: Human Anat & Phys 1****BIOL 255: 4 s.h.****Human Anatomy & Physiology II**

Study of the structure and function of the human body. This second semester of a two-semester sequence deals with the development, histology, gross anatomy, function and pathophysiology of the endocrine, circulatory, respiratory, digestive, urinary, and reproductive systems. 3 hrs. lec., 3 hrs. lab. Prereq: BIOL 254.

BIOL 255H: 4 s.h.**Hon: Human Anat/Phys 2****BIOL 256: 3 s.h.****Nutrition (G2, W)**

Principles of adequate nutrition including digestion and metabolism of foods; energy, protein, mineral and vitamin needs; environmental and industrial contaminants, additives and carcinogens; dietary treatment for nutritional disorders. 3 hrs. lec. Prereq: BIOL 100 and ENGL 110. No credit toward BIOL major or minor. No credit given if credit earned for BIOL 352.

BIOL 257: 1 s.h.**Introduction to Allied Health Professions**

A survey of the various disciplines in the allied health field. The course describes the type of training offered by hospitals for students who are planning to major in a health profession and for students who are undecided on a career. 1 hr. lec. Offered in fall.

BIOL 266H: 1 s.h.**Hnrs:Adv Princ Cell Biology**

Cellular operations and processes: hormonal control of cell physiology, secretory activities and vesicular trafficking, control of cell division, neu-rotransmission, control of muscle contraction, signal transduction, interrupted genes, cell recognition, etc. Students explore and lead discussions on one of these topics. Completion of both BIOL/HNRS 266 and BIOL 263 earns 5 credits to be counted as one course in the G2 block. BIOL/ HNRS 266 may not be used independently to fulfill a G2 requirement. 1 hr. seminar. Offered periodically. Prereq: completion of BIOL 362 or BIOL 263 with a grade of B- or higher and member of University Honors College, or 3.35 GPA, or instructor's permission.

BIOL 281: 3 s.h.**Behavioral Biology (G2, W)**

Provides an evolutionary and ethological frame of reference for further studies in psychology and animal behavior. Lectures supplemented by demonstrations and A-V media cover animal diversity, nervous systems, sensory reception, communication and behavior. 3 hrs. lec. Offered in fall or spring. Prereq: BIOL 100 or BIOL 101, and ENGL 110. No credit toward BIOL major.

BIOL 290: 3 s.h.**Coastal Marine Biology**

Introduction to marine organisms, marine communities, and the physical, chemical, and biological parameters that shape them; laboratory and field work will emphasize local coastal marine ecosystems. 2 hrs. lec., 3 hrs. lab. Offered in summer at the Chincoteague Bay Field Station. Prereq: BIOL 211 or 1 year of college biology or permission of instructor. No credit given if credit earned for BIOL 291.

BIOL 291: 4 s.h.**Marine Biology (G2)**

An introduction to foundation topics within marine biology, including (1) phylogeny, morphology, and ecology of marine organisms, (2) marine geography and mapping, (3) life in a fluid environment, (4) microcosms: marine aquarium systems, (5) scientific illustration, (6) internships, coops, jobs, and careers in marine biology, and (7) current topics 2 hrs. lec., 3 hrs. lab. Weekend field trips. Prereq: C- or higher in BIOL 211.

BIOL 292: 1 s.h.**Problem Solving in Marine Biol**

Exploration of advanced topics in marine biology including quantitative reasoning for marine biologists as well as written and oral interpretation of primary research in marine biology. Prereq: placement in college-level mathematics or permission of instructor. No credit given if credit earned for BIOL 291.

BIOL 293: 3 s.h.**Coastal Ornithology**

Students will achieve a strong understanding of a variety of aspects in ornithology with the strongest focus on field techniques, including identification. Material covered will include evolution, anatomy, physiology, behavior and ecology. A portion of the course will include an overview of the avian families of North America, especially those found in coastal regions along the mid-Atlantic seaboard. The field component for this course will include mist netting, census techniques and field identification. Emphasis will be placed on field research and a portion of the course will involve the development of a novel research idea in ornithology.

BIOL 294: 3 s.h.**Coral Reef Ecology**

The focus of this course is to introduce students to the unique aspects of coral reefs, and to provide a working knowledge of reef species and reef ecology. Students will learn basic taxonomy, biology, ecology, and conservation of coral reefs and the organisms associated with this habitat. Laboratory will consist of hands-on field experiences in a coral reef habitat. Students will learn techniques for study and assessment of marine habitats and complete an independent project.

BIOL 295: 3 s.h.**Marine Invertebrates**

The invertebrate phyla with emphasis on development, reproduction, structure, function and classification of selected marine organisms. Laboratory and field experience in collection, preservation and classification of the phyla.

BIOL 296: 3 s.h.**Marine Ecology**

Interrelationships among animals, plants and physical and chemical aspects of the environment will be studied, with stress on adaptations for survival that are unique to the marine environment.

BIOL 300: 1-15 s.h.**Co-Op Ed Experience in Biol**

Co-Op Ed Experience in Biol

BIOL 318: 4 s.h.**Comparative Vertebrate Anatomy**

Functional and comparative anatomy of selected vertebrates with developmental and evolutionary perspectives. Lab will primarily consist of dissection and histological analyses of animals representing various vertebrate classes. Students will learn phylogenetic approaches for studying vertebrate diversity and complete an independent project. 3 hrs. lec., 3 hrs. lab. Prereq: BIOL 211 and BIOL 362 or 263, or permission of instructor.

BIOL 324: 4 s.h.**Plant Biochemistry**

A study of enzymes and pathways involved in plant metabolism as related to plant cell structure, function and plant development. Topics include plant bioenergetics, biosynthesis of plant hormones and elicitor molecules, signal perception and transduction, and secondary metabolites (natural products). 3 hrs. lec., 3 hrs. lab. Prereq: BIOL 221 and BIOL 362 or BIOL 263, CHEM 232 or CHEM 235.

BIOL 325: 3 s.h.**Plant Systematics**

A survey of local vascular flora, use of dichotomous keys in identifying plants, distinguishing features of common plant families, principles of plant systematics. Phylogenetic, biosystematic and nomenclatural concepts are considered. 2 hrs. lec., 3 hrs. lab. Offered in fall. Prereq: C- or higher in BIOL 221.

BIOL 327: 3 s.h.**Horticultural Science**

Principles of horticultural science including regulation of plant growth, propagation and breeding, plant nutrition, pruning, plant diseases and special topics related to individual types of plants. Laboratory includes propagation and handling of plants in the greenhouse and field trips. 2 hrs. lec., 3 hrs. lab. Offered in spring. Prereq: BIOL 221 or permission of instructor.

BIOL 327H: 3 s.h.**Hon: Horticultural Science****BIOL 329: 3 s.h.****Plant-Insect Interactions**

The chemical and biological interactions between plants and insects will be extensively examined with particular emphasis on the chemical ecology of important behaviors such as herbivory, oviposition, and pollination. The chemical communications between plants and insects will be examined regarding how plant-produced chemicals influence, both directly and indirectly, the behaviors of insects. Chemical, anatomical, behavioral, environmental and evolutionary concepts linked to plant-insect interactions will be examined. Unique laboratory experiences will include the design and implementation of an independent research project and the rearing of Lepidoptera to establish research colonies. 2 hrs. lec., 3 hrs. lab. Prereq: BIOL 221, BIOL 211, and either CHEM 231 or CHEM 235 or permission of the instructor.

BIOL 340: 3 s.h.**Prspctv in Environm Awareness (P)**

Interdisciplinary study of current environmental problems and their implications on future habitability of the planet. Physical, biological and social aspects of alterations to ecosystems presented and solutions considered. Course includes lectures, open forums and student participation. Offered in fall and spring. Prereq: COMM 100, ENGL 110, junior status and at least one science (G2 block) and one social science course (G3 block).

BIOL 340H: 3 s.h.**HNRS:Persp in Environ Awareness (P)**

BIOL 343: 4 s.h.**Principles of Ecology & Evolution**

The basic concepts and principles of evolution and ecology. Topics include natural selection, genetic variation, macro- and microevolution, population genetics, evolutionary stable strategies, species concepts, biodiversity, extinction, reproductive strategies, population dynamics, the ecological niche concept, predation, competition, mutualism, parasitism, coevolution, biogeography, disturbance ecology, and ecosystem structure and function. 3 hrs. lec., 3 hrs. lab. Offered in fall and spring. Prereq: BIOL 101 or 100 with a grade of C- or higher; B- or higher in BIOL 100 for biology majors; C- or higher in BIOL 211 and BIOL 221; MATH 151, 160 or math equivalent; ENGL 110.

BIOL 343H: 4 s.h.**Hon: Ecology and Evolution****BIOL 344: 3 s.h.****Population Community Ecology**

An intermediate course that will explore population biology, species interactions, trophic structure, community organization, succession, island biogeography, and biological diversity at a more advanced level than BIOL 343. The laboratory portion of the course will focus on the use of quantitative methods and manipulative experimental designs to verify fundamental principles and test new hypotheses. 2 hrs. lec., 3 hrs. lab. Prereq: BIOL 343, MATH 151 or MATH 161, and BIOL 375.

BIOL 346: 3 s.h.**Ornithology (W)**

The study of the ecology, behavior, conservation, evolution, and physiology of birds. Lab work will focus on bird identification and field techniques to trap and survey for birds. 2 hrs. lec., 3 hrs. lab. Prereq: C- or higher in BIOL 211.

BIOL 352: 3 s.h.**Nutritional Science (W)**

Biological and biochemical roles of nutrients for the proper functioning of the human body. Nutrition concepts will be used to design and evaluate personal diet plans. No credit given if credit earned for BIOL 256. (BIOL 256 does not count for biology majors or minors.) Prereq: C- or higher in BIOL 362 or BIOL 263, ENGL 110.

BIOL 352H: 3 s.h.**Hon: Nutritional Science (W)****BIOL 356: 5 s.h.****Functional Human Anatomy**

A systemic approach to the study of the structure of the human body with discussion of general function. Course designed primarily for those planning to enter medical or allied health professions. Clinical laboratory experiences related to human anatomy. 3 hrs. lec., 4 hrs. lab. Offered in spring. Prereq: C- or higher in BIOL 211 and BIOL 362 or BIOL 263.

BIOL 361: 4 s.h.**Microbiology**

The structure, physiology and ecology of microorganisms. Symbiotic associations between organisms will be examined in depth. Principles of microbial virulence and immunology are also discussed. Laboratory investigations include the isolation and identification of unknown microorganisms. 3 hrs. lec., 3 hrs. lab. Offered in fall. Prereq: BIOL 101 C- or better or BIOL 100 B- or better; CHEM 112 (Prereq or Coreq) or CHEM 104

BIOL 361H: 4 s.h.**Hon: Microbiology****BIOL 362: 4 s.h.****Cell and Developmental Biology (G2, W)**

Cell structure and function, including cell ultrastructure, methods used in cell biology research, cell motility, signal transduction, cell division, macromolecules, metabolism and the cytomembrane system. Basic concepts in developmental biology are also covered: fertilization, early embryonic cleavage in model systems, cell-cell communication, extracellular matrix and research methods. Examples from developmental biology are employed to illustrate the functions and roles of cellular structures and processes. Laboratory includes isolation of cell components, fertilization and cleavage in sea urchins, microscopy and other techniques used in the study of cell and developmental biology. 3 hrs. lec., 3 hrs. lab. Offered in fall and spring. Prereq: BIOL 101 or 100 with a grade of C- or higher; B- or higher in BIOL 100 for biology majors; ENGL 110; CHEM 112 (Prereq or Coreq).

BIOL 362H: 4 s.h.**HNRS:Cell and Devel Biology****BIOL 363: 3 s.h.****Medical Microbiology**

An in-depth exploration into the nature of disease-causing microorganisms, with an emphasis on medically important bacteria, viruses and fungi. This course will provide a comprehensive analysis of the structure of microorganisms, epidemiology and pathogenesis of microbial diseases, control of microbes, host responses to infection, vaccination strategies and antimicrobial therapy. 3 hrs. lec. Prereq: BIOL 362 or BIOL 263.

BIOL 363H: 3 s.h.**Hon: Medical Microbiology****BIOL 364: 4 s.h.****Foundations of Genetics & Molecular Biology**

Concepts and principles essential for a basic understanding of genetics and molecular biology are covered. Topics include Mendelian genetics, gene mapping, molecular structure of the gene, gene expression and regulation, chromatin structure, molecular methodologies, human genome project, population genetics and evolution. 3 hrs. lec., 3 hrs. lab. Offered in fall, spring. Prereq: BIOL 101 or 100 with a grade of C- or higher; B- or higher in BIOL 100 for biology majors; CHEM 112.

BIOL 375: 3 s.h.**Biometry**

Use of statistical techniques in descriptive and experimental biology and the use of mathematical models in describing biological phenomena. 3 hrs. lec. Offered in fall, spring. Prereq: BIOL 100 or BIOL 101, and MATH 151 or higher.

BIOL 375H: 3 s.h.**Hon: Biometry****BIOL 385: 3 s.h.****Principles of Animal Behavior**

Animal groups from protozoa to mammals, studied from an ethologist's point of view. Inheritance, learning, development and motivations will be covered. 2 hrs. lec., 3 hr. labs. Offered in spring. Prereq: BIOL 211 and Junior Standing. BIOL 343 recommended.

BIOL 385H: 3 s.h.**H: Princ of Animal Behavior**

BIOL 392: 3 s.h.**Marine Mammals**

The distribution, population size, physiology, evolution, adaptations and ecological relationships of marine mammals will be studied with an emphasis on mammals of the Atlantic Ocean. This course will stress hands-on understanding of marine mammal physiology, behavior, population dynamics and species diversity. Laboratory and field work will include an extended off-campus field trip to facilities holding and/or studying marine mammals of the NE Atlantic Ocean. In addition, the laboratory portion of this course will emphasize data collection in the field, and subsequent analysis and presentation of the data through a required mini-research project.

BIOL 396: 3 s.h.**Ichthyology**

Morphology, anatomy, physiology, systematics and behavior of fishes. Laboratory and field experiences involve collection and study of specimens from nearby field sites. Zoogeography, life histories and speciation also discussed. Prereq: BIOL 211 or 1 year college biology (department override required if BIOL 211 not completed)

BIOL 397: 3 s.h.**Marine Botany**

The taxonomy, ecology, distribution, life histories, physiology, and economic status of marine and marine-fringe plants of the Middle Atlantic coast. Covers techniques of collecting, preserving, identifying, and cataloging.

BIOL 400: 3-12 s.h.**Co-Op Ed Experience in Biol**

Co-Op Ed Experience in Biol

BIOL 415: 3 s.h.**Mammalogy (W)**

The study of the ecology, behavior, conservation, evolution, and physiology of mammals. Lab work will focus on mammal identification and field techniques to trap and survey for mammals. 2 hrs. lec., 3 hrs. lab. Weekend field trips. Prereq: C- or higher in BIOL 211.

BIOL 415H: 3 s.h.**Hon: Mammalogy (W)****BIOL 416: 3 s.h.****Entomology**

Introduction to insects with emphasis on structure and function, behavior, adaptations, ecology, systematics, and economic and medical significance. Collecting, pinning and preservation techniques are covered. Field trips. 2 hrs. lec., 3 hrs. lab. Offered periodically. Prereq: C- or higher in BIOL 211.

BIOL 418: 4 s.h.**Aquatic Entomology**

Aquatic entomology covers topics such as aquatic insect morphology, physiology, ecology, behavior and evolution in a variety of aquatic systems and includes a significant taxonomic component. Each student will be required to make an aquatic insect collection. Prereq: BIOL 211 and BIOL 343 or permission of instructor. 3 hrs lec., 3 hrs. lab.

BIOL 424: 3 s.h.**Mycology**

The taxonomy, morphology, physiology and ecology of fungi. Laboratory activities include surveys of local populations of fleshy fungi, fungal pathogens of plants and soil fungi; physiological studies on growth and reproduction; experimental studies of fungal ecology; and studies of comparative morphology of diverse fungal groups. 2 hrs. lec., 3 hrs. lab. Offered periodically. Prereq: C- or higher in BIOL 221 and BIOL 362 or BIOL 263.

BIOL 435: 3 s.h.**Animal Physiology**

Structure and functions of animals. Independent investigation and recent physiological theories emphasized. 2 hrs. lec., 3 hrs. lab. Offered in fall. Prereq: C- or higher in BIOL 211 and BIOL 362 or BIOL 263; CHEM 112.

BIOL 436: 3 s.h.**Plant Physiology**

Life processes of plants. Water relations, nutrition, translocation, photosynthesis, metabolism, growth, development, and reproduction will be considered with particular reference to higher plants. 2 hrs. lec., 3 hrs. lab. Offered in spring. Prereq: BIOL 221 and BIOL 362 or BIOL 263. CHEM 231 or 235 recommended.

BIOL 437: 3 s.h.**Endocrinology**

The role of hormones in the integration and control of physiological and developmental process is stressed as well as the molecular mechanism of hormone action. 3 hrs. lec. Offered in fall. Prereq: BIOL 362 or BIOL 263.

BIOL 437H: 3 s.h.**Hon: Endocrinology****BIOL 438: 3 s.h.****Neurobiology**

The structure and function of the nervous system. Lectures will cover a broad range of topics, from the molecular to the cognitive. One of the major themes is the relationship between the brain and behavior. 3 hrs. lec. Offered periodically. Prereq: BIOL 362 or BIOL 263.

BIOL 442: 3 s.h.**Wildlife Ecology & Management**

Wildlife management involves protecting and conserving endangered species, increasing the number of game species and controlling pest species. We will discuss how the understanding of wildlife ecology, history, policy and statistics help shape the decisions a wildlife manager makes in the real world. Unique laboratory experiences will include field orienteering, radiotracking, soil and water assessment, vegetative measurements and animal trapping. Students will use these lab experiences to collect and analyze data in the development of a wildlife management plan. 2 hrs. lec., 3 hrs. lab. Prereq: BIOL 375 and BIOL 343.

BIOL 443: 3 s.h.**Conservation Biology**

Population ecology and genetics and how it is applied to the conservation of rare, threatened, and endangered species. Emphasis will be on the regulation of abundance, theoretical models of population dynamics, experimental design, sampling approaches and case studies. 2 hrs. lec., 3 hrs. lab. Prereq: C- or higher in BIOL 101, 343.

BIOL 445: 3 s.h.**Aquatic Biology**

Study of the physical and biotic aspects of temporary pools, streams, ponds and rivers. Field trips. 2 hrs. lec., 3 hrs. lab. Offered in spring. Prereq: BIOL 211, 221, PHYS 132 or 232 desirable.

BIOL 446: 3 s.h.**Ecosystems (W)**

Ecosystem processes including nutrient cycles, energy budgets and trophodynamics are discussed for terrestrial, coastal and marine ecosystems. Processes are discussed for ecosystem types such as those controlled by fire, volcanism, chemosynthetic bacteria, detrital food resources, herbivory and predation. Ecosystems viewed in a global perspective to understand global carbon and nutrient cycles. 3 hrs. lec./discussion. Offered in spring of even years. Prereq: BIOL 343 and ENGL 110.

BIOL 447: 4 s.h.**Chesapeake Bay System (W)**

Study of the effects of human activity on the ecosystems of the Chesapeake Bay System and the role of ecological principles in current restoration efforts. Investigation of how agricultural practices, riparian forests, tidal and nontidal wetlands and urban development affect the input of nutrients and toxins, and the estuarine processes in Chesapeake Bay that cause eutrophication and population declines in fisheries. 2 hrs. lec., 4 hrs. lab/field. Offered in fall. Prereq: BIOL 343 and ENGL 110.

BIOL 448: 3 s.h.**Wetland Ecology and Management**

The investigation of the various biotic and abiotic components of wetland ecosystems, with an emphasis on wetland vegetation, hydrology, and biogeochemical processes. Course content will be a mix of fundamental and applied ecology and will cover topics such as vegetation succession, hydric soil, nutrient cycling, wetland classification and delineation, restoration and management, invasive species, and wetland loss. Prereq: BIOL 343 or permission of instructor.

BIOL 454: 3 s.h.**Immunology**

The development of innate, humoral and cellular immunity to an antigenic stimulus is discussed. Role of these mechanisms in immunogenetics, immunologically mediated disease, immunological protection against infectious agents, use of antibodies in diagnostic tests, and antibody- and cell-based cancer therapy are also considered. 3 hrs. lec. Offered in spring. Prereq: BIOL 362 or 263.

BIOL 454H: 2 s.h.**Hon: Immunology****BIOL 455: 3 s.h.****Cardiopulmonary Physiology**

Cardiovascular and pulmonary function. Covers heart muscle, electro-mechanical properties of the heart, hemodynamics, mechanics of ventilation, gas transport and cardiopulmonary insufficiencies. Laboratory exercises include use of human subjects, animal experimentation and computer simulations. 2 hrs. lec., 3 hrs. lab. Offered in spring. Prereq: BIOL 211, 362 or 263, 356 and CHEM 231 or 235 for the B.S. in biology; CHEM 103 and CHEM 104 for the B.S. in allied health technology.

BIOL 461H: 3 s.h.**H:General Microbiology****BIOL 462: 4 s.h.****Molecular Biology (W)**

The molecular and macromolecular basis of life. The structure and function of cellular macromolecules, molecular techniques of genetic analysis and the control of cellular processes will be examined in depth. 3 hrs. lec., 3 hrs. lab. Offered in fall. Prereq: BIOL 362, 364 or 365, and ENGL 110. BIOL 461 or CHEM 326 recommended.

BIOL 463: 4 s.h.**Virology**

Comprehensive investigation of animal viruses. In-depth analysis of virus particles, modes of replication, epidemiology of virus infection, virus host interactions and vaccines. Focus is on medically important viruses such as herpes, influenza, hepatitis and human immunodeficiency viruses. Laboratory exercises include the culture and analysis of viruses in non-mammalian systems. 3 hrs. lec., 3 hrs. lab. Prereq: BIOL 364 or permission of instructor.

BIOL 465: 3 s.h.**Developmental Biology**

Principles of development and differentiation in animals and plants at the molecular and supramolecular levels of organization. The laboratory includes both experimental and descriptive embryology. 2 hrs. lec., 3 hrs. lab. Offered in spring. BIOL 362 or 263, 364 or 365, or permission of instructor.

BIOL 466: 3 s.h.**Molecular and Cell Techniques**

Application and theory of techniques commonly used in biotechnology, and cell and molecular biological research. Cell culture, plant tissue culture, immunological techniques, cell fusion, radioisotope labeling and detection, centrifugation, microscopic techniques and electrophoretic protocols will be covered in depth. Intended for biology B.S. majors in the molecular biology/biotechnology option. 5 hrs. integrated lecture/lab. Offered in spring. Prereq: BIOL 462 or permission of the instructor.

BIOL 467: 3 s.h.**Human Genetics:Analysis/Apps (W)**

Applications of traditional and molecular approaches in understanding the genetic basis for human traits. Gene mapping and identification, cytogenetics and DNA sequence analysis will be covered in depth. Gene function, regulation, mutations and cloning will be explored in the context of human diseases. The Human Genome Project, genetic diagnostics, gene therapy and transgenic organisms will be addressed, along with the genetic basis of cancer, behavior, immunity and development. Genetic counseling and medical genetics will be discussed. 3 hrs. lec./discussion. Offered annually. Prereq: BIOL 364 or 365, ENGL 110.

BIOL 470: 1,2 s.h.**Biology Colloquium**

An opportunity to meet visiting scientists and to discuss their research work. Students will read and discuss, in a seminar format, assigned papers prior to the presentation of the colloquium by the visiting scholar. In addition, they will be expected to participate in discussions with the speaker after the colloquium hosted by the Department of Biology. Offered periodically. Prereq: BIOL 101 or BIOL 100. Other courses indicated by instructor.

BIOL 471: 4 s.h.**Topics In Biology**

Detailed investigations of a topic of current interest. Topic to be announced each time course is offered. Offered periodically. Prereq: Upperclass standing or permission of instructor.

BIOL 471H: 4 s.h.**Hon: Topics in BIOL:****BIOL 472: 1,2 s.h.****Seminar In Biology**

Group discussions. General theme to be determined by professor. Offered annually. Prereq: 16 s.h. of biology and courses indicated by the instructor.

BIOL 472H: 1,2 s.h.

HNRS:Seminar in Biology

BIOL 473: 1 s.h.

Methods/Teaching Biological Issues in the Secondary School

A seminar for prospective life science teachers to consider methods a teacher might employ to present controversial aspects of biology in intellectually honest, balanced ways which also demonstrate sensitivity to the various moral, ethical and political dilemmas secondary school students may encounter. 1 hr. lecture. Offered annually. Co- or prereq: EDSE 435; required of all B.S.Ed./BIOL students prior to or with EDSE 461.

BIOL 483: 3 s.h.

Applied Ethology

An introduction to applied animal behavior, including (1) the behavior of companion animals, animals in zoos & aquaria, animals in labs, and animals in agriculture/aquaculture; (2) animal welfare, (3) ethical issues in animal use, (4) methods of training captive animals, and (5) career options and certifications in animal behavior. 3 hrs lecture. Offered periodically. Prereq: PSYC 316 or BIOL 385; PSYC 300 or BIOL 300 or PSYC 495; Senior standing or permission of instructor. Students cannot also earn credit in PSYC 483.

BIOL 484: 3 s.h.

Mech of Animal Behavior

An exploration of the physiological mechanisms that regulate animal behavior. Nervous and endocrine system physiology are examined and applied to understanding behavioral neuroendocrinology, the integrative study of hormones, brain, and behavior. Research methods in behavioral physiology and the importance of genetic control mechanisms are recurrent topics. A comparative approach is taken, and behavioral physiology is considered in ecological and evolutionary contexts. 3 hrs. lec. Prereq: BIOL 362 or permission of instructor. BIOL 385 recommended.

BIOL 486: 3 s.h.

Behavioral Ecology

An in-depth examination of the evolution of animal behavior via natural selection with a on the adaptive significance (i.e., fitness consequences) of behaviors involved in foraging, resource defense, cooperation, mating, parental care, and communication. Predator-prey interactions, animal sociality, and approaches to studying behavioral ecology are recurrent topics. Involves a substantial field component where students learn to observe, document, and quantify animal behavior in the wild. 2 hrs. lec., 3 hrs. lab/field. Prereq: C- or higher in BIOL 343. BIOL 385 recommended.

BIOL 489: 1-4 s.h.

Honors Course

For the definition of honors course and student eligibility, refer to the Special Academic Opportunities section of this catalog.

BIOL 495: 3 s.h.

Biological Oceanography

Intensive summer lecture and field course teaching the physical, chemical and biological factors controlling the structure and dynamics of marine ecosystems. Classroom instruction focuses on theoretical principles concerning the environmental control of phytoplankton communities by sunlight, nutrients and grazing. The dynamics and complexity of marine food webs including the phytoplankton, zooplankton and upper trophic levels. Laboratory and field instruction focuses on ocean monitoring and sampling from research vessels, biomass determination and identification of key plankton species, measurement of the rates of net and gross primary production using oxygen light-dark bottle experiments, and optical and chemical techniques of determining phytoplankton biomass and species composition. Approximately 40-50% of course time is spent in field. Prerequisites: C- or higher in ESCI 261 and BIOL (211 or 221), or permission of instructor.

BIOL 498: 1-4 s.h.

Independent Study

Student research on a topic agreed on with faculty supervisor. Applicant for independent study is required to submit a Request for Special Study Assignment form.

BIOL 499: 1-4 s.h.

Departmental Honors

For the definition of honors course and student eligibility, refer to the Special Academic Opportunities section of this catalog.

RETENTION-IN-THE-MAJOR POLICY

University requirements for retention must be met. In addition, all biology majors must earn grades of C- or higher in all core courses (BIOL 101 Foundations of Biology, BIOL 211 Concepts of Zoology, BIOL 221 Concepts of Botany, BIOL 343 Principles of Ecology & Evolution, BIOL 362 Cell and Developmental Biology, BIOL 364 Foundations of Genetics & Molecular Biology) required for their option. These requirements must be satisfied before completion of 90 Millersville University credit hours. Those who change their major or option, and transfer students with more than 60 credits, must satisfy these requirements before completing 45 additional credits. Those transferring into the major may substitute BIOL 100 General Biology for BIOL 101 Foundations of Biology if they earn a grade of B- or higher in this course.

For most biology majors, the core would include all six courses. Those in allied health options (medical technology, nuclear medicine technology, pre-athletic training, respiratory therapy, and sports medicine), who are not required to complete six core courses, would be required to earn a C- or higher in all of the core courses required for that particular option.