Department of Biology (BIO)

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The primary mission of the Department of Biology is to provide the student with a well-balanced background in the life sciences. A student majoring in biology will examine the characteristics of life at all levels, from the workings of a single cell to the dynamics of an ecosystem. In addition to providing the student with a broad understanding of and appreciation for life and its processes, the curriculum is designed to prepare students for careers in biology or for studies at the graduate level. To meet these objectives the department has established the degree concentrations listed below, each with a somewhat different focus within the discipline.

All majors in biology require a minimum of 128 semester hours for the degree. The Bachelor of Arts degree requires a minor. In addition to general education, major and minor requirements, electives must be taken to meet the total required minimum hours. Two semester hours of free electives OUTSIDE the major discipline are required.

All biology majors are required to complete 44 semester hours of general education requirements. Additionally, they must complete the course requirements indicated below in the degree they select as the one most suited to their educational needs.

The Bachelor of Arts degree in Biology (208A/26.0101)

This is the most flexible program in the Department of Biology. It is designed for highly directed students who wish to focus on disciplines not addressed by the other degree concentrations. In addition to the biology core (BIO 1801 and BIO 1802), students pursuing the B.A. degree must complete BIO 2400 or BIO 2700; BIO 3436; BIO 4501 or BIO 4700 or BIO 4910; and 17 s.h. in biology including completion of a junior-level writing course. It is required that at least one course must be selected from each of the following areas (Area A: Cellular or Subcellular, Area B: Evolution or Ecology or Environment, Area C: Anatomy or Physiology, and Area D: Biodiversity). The following 31 s.h. of cognate courses are also required: CHE 1101 & CHE 1110; CHE 1102 & CHE 1120; CHE 2201 & CHE 2203; CHE 2202 & CHE 2204; MAT 1110; STT 2810; and a minimum of 8 s.h. in either Physics or Geography. Students pursuing a B.A. degree must also select a minor and complete foreign language requirements as listed elsewhere in the Undergraduate Bulletin. Students will complete 128 semester hours for this degree. A candidate for the Bachelor of Arts degree in Biology may count no more than a total of 46 semester hours above general education requirements in biology.

Area A: Cellular or Subcellular
  BIO 2400 Genetics*, BIO 2410 Genetics Laboratory, BIO 2600 Cell Biology*, BIO 2610 Cell Biology Laboratory, BIO 2700 Human Genetics*, BIO 3308 Microbiology, BIO 3309 Developmental Biology, BIO 3800 Molecular Biology, BIO 4564 Microscopy, BIO 4568 Immunology

Area B: Evolution or Ecology or Environment
  BIO 2000 Introduction to Botany, BIO 2001 Introduction to Zoology, BIO 3302 Ecology, BIO 3312 Environmental Studies*, BIO 3320 Air Pollution*, BIO 3436 Intro to Evolution, BIO 4571 Plant/Insect Interactions, BIO 4601 Animal Behavior

Area C: Anatomy or Physiology
  BIO 3301 Human Systems Physiology, BIO 3314 Comparative Vertebrate Zoology, BIO 4555 Plant Physiology, BIO 4563 Biology of Aging*, BIO 4569 Invertebrate Zoology

Area D: Biodiversity
  BIO 2000 Introduction to Botany, BIO 2001 Introduction to Zoology, BIO 3304 Systematic Botany, BIO 3310 Marine Sciences, BIO 4551 Ornithology, BIO 4552 Entomology, BIO 4556 Mycology, BIO 4557 Ichthyology, BIO 4558 Taxonomy of the Fleshy Fungi, BIO 4559 Mammalogy, BIO 4560 Herpetology, BIO 4569 Invertebrate Zoology, BIO 4570 Parasitology

Courses marked with an asterisk (*) either do not have a laboratory or the laboratory is a separate 1 s.h. course.
The Bachelor of Science degree in Biology/Ecology, Evolution and Environmental Biology (205A/26.1301)
requires 128 semester hours including the biology core (BIO 1801 and BIO 1802); and completion of a minimum of 51 s.h. from
the following: BIO 2400 or BIO 2700; BIO 3302; BIO 3436; BIO 4501 or BIO 4700 or BIO 4910; one course selected from either
Area A or Area C (see list above); two courses with labs selected from Area B (listed above); two additional courses selected from
Area D (listed above); and additional elective hours in Biology, Chemistry, Physics, Geology, and selected courses in Anthropology,
Geography, or Sustainable Development. At least one of the courses must fulfill the requirements for a junior-level writing course.
The following cognate courses are also required: CHE 1101 & CHE 1110; CHE 1102 & CHE 1120; CHE 2101 & CHE 2203*; MAT
1110; STT 2810. *[Note: The sequence of CHE 2201/CHE 2203 and CHE 2202/CHE 2204 can substitute for CHE 2101/CHE 2203.]

The Bachelor of Science degree in Biology, Cell/Molecular Biology (124A/26.0101)
In addition to the general objectives of the department, this degree is designed to prepare students for successful admission into
professional schools or to continue their studies in graduate and health-care programs. The Bachelor of Science degree in Biology,
Cell/Molecular Biology requires 128 semester hours including the biology core (BIO 1801 and BIO 1802); and completion of the
following: BIO 2400 or BIO 2700; BIO 2600; BIO 2410 or BIO 2610; BIO 3301 or BIO 3314 or BIO 4555; BIO 3436; BIO 3800; BIO
4501 or BIO 4700 or BIO 4910; one course from Area B or Area D; and additional courses from Area A or Area C to equal a minimum
of 78 s.h. At least one of the courses must fulfill the requirements for a junior-level writing course. The following cognate courses are
also required CHE 1101 & CHE 1110; CHE 1102 & CHE 1120; CHE 2201 & CHE 2203; CHE 2202 & CHE 2204; CHE 4580; PHY
1103 & PHY 1103; MAT 1110; and STT 2810.

Pre-professional students pursuing health-related careers may be interested in the undergraduate minor in Medical Humanities
(605/30.9999). Consult the Honors College section of this catalog for course requirements and additional information.

The Bachelor of Science degree in Biology, Secondary Education (209A/13.1322)[T] (Teaching)
In addition to the general objectives of the department, this degree is designed for students intending to pursue careers in teaching.
Students successfully completing this degree will meet the North Carolina Department of Public Instruction requirements to teach
biology full-time in grades 9-12 and will be eligible for a North Carolina Secondary General Science teaching license.

The Bachelor of Science degree in Biology, Secondary Education (Teaching) requires 128 semester hours including the biology core
(BIO 1801 and BIO 1802) and completion of the following: BIO 2400, BIO 2410, BIO 3436, BIO 3301 or BIO 4555, BIO 3312, BIO
3521, BIO 3800; one course from Area D (see list above) (3 s.h. minimum); CHE 1101, CHE 1110, CHE 1102, CHE 1120, CHE 2101,
CHE 2203, MAT 1110, STT 2810, PHY 1103 and PHY 1104, GLY 1101, GS 4403 and GS 4404 (minimum grade of "C" required in GS
4403 and GS 4404); plus course work required by the Reich College of Education for teacher licensure. The student should consult
the requirements for licensure listed under the Department of Curriculum and Instruction.

The Bachelor of Science degree in Environmental Science (121A/03.0104)
In addition to the discipline-specific degrees offered by the department, an interdisciplinary Bachelor of Science degree in
Environmental Science provides a broad and rigorous curriculum in the natural sciences. Students completing this degree will be
prepared to enter environmental science positions in industry, business, or government as well as pursue post-graduate studies in
various areas of environmental science. Please refer to the Environmental Science Program in the College of Arts and Sciences
section of this Undergraduate Bulletin for the course requirements.

Biology Minor (208/26.0101)
A minor in Biology consists of a minimum of 14 semester hours taken in courses numbered 2000 and above.

Honors Program in Biology
The Department of Biology provides the opportunity for highly qualified students to graduate with departmental honors in Biology.
In order to graduate with “honors in Biology,” the student must have at least a 3.5 overall GPA; a GPA of at least 3.5 in the major
(calculation includes cognate courses); and must have completed a minimum of 9 semester hours of honors courses in Biology,
including BIO 4518 (Honors Research, 3 s.h.) and BIO 4519 (Biology Honors Thesis, 3 s.h.).

Admission to the Biology Honors Program - Students must apply for admission to the honors program in Biology. Applications will
be considered by the department’s Scholarship Committee and by the faculty director of the Biology Honors Program. A student is
eligible to apply for admission into the Biology honors program if she or he:

1. Has completed at least 45 semester hours of course work with a minimum of 15 semester hours completed at Appalachian
State University;
2. Is majoring in one of the degree programs in the Department of Biology;
3. Has completed BIO 2400 or BIO 2700 with a grade of "B" or higher;
4. Has an overall GPA of at least 3.5 and a GPA of at least 3.5 in the major; and
5. Has identified a Biology faculty member who has agreed to direct the student’s Honors Research (BIO 4518 and Biology Honors Thesis (BIO 4519).

Space in the Biology Honors Program is limited, and not all students meeting the application criteria may be accepted into the Biology Honors Program.

Master of Science
The Department of Biology offers a Master of Science degree in Biology with concentrations in Cell and Molecular Biology, and General Biology. Consult the Graduate Bulletin for further information.

Courses of Instruction in Biology, and General Science (BIO, GS)
This catalog reflects fall and spring semester offerings. Go to www.summerschool.appstate.edu for courses offered in summer terms. (For an explanation of the prefixes used in the following courses, see the listing of Course Prefixes.)

BIOLOGY (BIO)

BIO 1101. Biology in Society I (4).F;S.
GEN ED: Science Inquiry Perspective (Theme: "Biology and Society")
This course will focus primarily on issues relating to life at the level of the organism inward. The course will examine the broad concepts of how life is defined by the processes of heredity, reproduction and metabolism. These concepts will be examined by studies of societal issues such as cancer, nutrition, gene therapy, patterns of inheritance, drug therapy, and evolution at the cellular level. Lecture three hours, laboratory two hours. (CORE: NATURAL SCIENCES) (NUMERICAL DATA) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.)

BIO 1101 WILL NOT SUBSTITUTE FOR BIO 1801 FOR SCIENCE MAJORS.

BIO 1102. Biology in Society II (4).F;
GEN ED: Science Inquiry Perspective (Themes: "Biology and Society" and "Life, Earth, and Evolution")
This course will primarily focus on issues relating to life at the level of the organism outward. The course will examine the broad concepts of evolutionary processes, the interdependent nature of living organisms, the diversity of life, and the evolution of organ systems. These concepts will be examined by studies of societal issues such as the biodiversity crisis, human evolution, plants and agriculture, the threats from microbes, and issues in conservation ecology. Lecture three hours, laboratory two hours. (CORE: NATURAL SCIENCES) (NUMERICAL DATA) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.)

BIO 1102 WILL NOT SUBSTITUTE FOR BIO 1802 FOR SCIENCE MAJORS.

BIO 1103. Global Climate Change and Earth’s Life (4).S.
GEN ED: Science Inquiry Perspective (Theme: "Global Environmental Change")
A course examining the effects of global climate change on earth’s organisms. Lecture combines biological concepts with current knowledge and predictions to provide a broad introduction to key changes possible in earth’s biota in a future world. Laboratory provides a hands-on approach to investigating climate change questions. Submission of on-line essays, group discussions and summary reports from laboratory experiments required. Lecture three hours, laboratory two hours.

BIO 1801. Biological Concepts I (4).F;S.
This course will investigate the history of science and the scientific method, the chemical basis of life, cell biology, bioenergetics, DNA structure and function, as well as general and molecular genetics. The course will cover the evolutionary basis of life and the application of evolutionary theories to the study of life. Lecture three hours, laboratory three hours. Corequisite: CHE 1101.

UNLESS NOTED, BIO 1801 IS THE MINIMUM PREREQUISITE FOR ALL BIO COURSES NUMBERED 2000 AND ABOVE.

BIO 1802. Biological Concepts II (4).F;
The course will cover the development and application of evolutionary theory to the study of organismal biology. Course material will include discussions of the classification and evolutionary relationships of the domains of life, principles of plant and animal physiology, and overviews of population biology and ecology. Lecture three hours, laboratory three hours. Prerequisite: BIO 1801 with a grade of “C” or higher.

ALL BIOLOGY MAJORS MUST COMPLETE BIO 1801 & BIO 1802 BEFORE TAKING ANY OTHER BIOLOGY COURSE FOR THE MAJOR.

BIO 2000. Introduction to Botany (4).F;
Survey of the major topics in plant biology including physiology, morphology, ecology, evolution, aspects of plant diversity and water relations in plants. Lecture three hours, laboratory three hours.
BIO 2001. Introduction to Zoology (4).F;S.
Integrated and phylogenetic study of the animal kingdom. The basic biological problems facing animals will be considered in the context of morphology and evolutionary history. Lecture three hours, laboratory three hours.

BIO 2200. Human Microbiology (4).S.
The main objective of this course is to present the basic principles of microbiology and the nature of microbial diseases to students pursuing health-related fields. The course will focus on microorganisms which are pathogenic to humans, the diseases they cause and the treatment and prevention of those diseases. Lecture three hours, laboratory three hours. Prerequisites: CHE 1101, CHE 1110, and CHE 1102, CHE 1120. Note: BIO 2200 is not open to biology majors for credit.

BIO 2400. Genetics (3).F;S.
This course will cover aspects of transmission genetics, cytogenetics, molecular genetics and the importance of genetics to an understanding of evolution and population dynamics. The genetics of viruses, prokaryotes, and eukaryotes will be studied. Prerequisites: BIO 1801, CHE 1102, and MAT 1025. Lecture three hours. Students cannot receive credit for both BIO 2400 and BIO 2700. (NUMERICAL DATA) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.)

BIO 2410. Genetics Laboratory (1).F;S.
Laboratory investigations of genetic systems in plants, animals, and fungi. Prerequisite or corequisite: BIO 2400 or BIO 2700. Laboratory three hours. (WRITING; NUMERICAL DATA) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.)

BIO 2500. Independent Study (1-4).F;S.

BIO 2600. Cell Biology (3).F;S.
Cell biology provides an opportunity to discover in detail the inner workings of cells. Discussion topics include biomolecules, bioenergetics, organization, movement and regulation as well as the intercellular interactions. Lecture three hours. Prerequisite: CHE 1102.

BIO 2610. Cell Biology Laboratory (1).F;S.
Laboratory exercises will provide an opportunity to experience how scientists learn about cells. Experiments will use modern techniques to probe cellular structure, composition and function. Laboratory three hours. Prerequisite: MAT 1025 or equivalent. Prerequisite or corequisite: BIO 2600.

BIO 2700. Human Genetics (3).F;S.
This course examines the principles of genetics from a human perspective. The history of genetic thought will be discussed, as well as pedigree analysis, genetics of human disease, human population genetics, and selected topics on the Human Genome project, behavior, and multifactorial traits. Prerequisites: BIO 1801, CHE 1102, and MAT 1025. Students cannot receive credit for both BIO 2400 and BIO 2700.

BIO 2800. Biotechnology and Society (3).S. Alternate years.
A look at how the recent advances in biotechnology affect society and individuals. Special emphasis is placed on the possibilities that biotechnology brings and the decisions it forces on society. Topics include reproductive technology, population problems, extending life, considerations of the ever-changing definition of death, genetic testing and screening, ecological problems, and others as new technological advances develop. Prerequisite: at least one course in biology, sociology, or ethics. (WRITING; SPEAKING)

BIO 3301. Human Systems Physiology (4).F;S.
**GEN ED: Junior Writing in the Discipline (WID)**
A study of the fundamental principles of human physiology with an emphasis on systemic function. Lecture three hours, laboratory three hours. Prerequisites: one semester of organic chemistry (CHE 2201 or CHE 2101); and ENG 2001 or its equivalent. (WRITING; NUMERICAL DATA) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.)

BIO 3302. Ecology (4).F;S.
A study of the interaction of organisms with their environment. Principles discussed will include natural selection and adaptation, population growth and regulation, interspecific interactions, including competition, predation, parasite-host relationships and mutualism, the structure and function of communities and ecosystems, geographical ecology, and human impacts on the biosphere. STT 2810 recommended. Lecture three hours, laboratory three hours. (NUMERICAL DATA; COMPUTER) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.)
BIO 3304. Systematic Botany (4).F.
This course begins with the study of plant structure, learning about form and function. Both past and current methods of classification and their theoretical frameworks will be explored. Throughout the semester, in both lecture and lab/field, the tremendous diversity of land plants and the tools used to reconstruct the evolutionary history of plants will be examined. Lecture three hours, laboratory three hours. Prerequisite: BIO 2000 or permission of the instructor.

BIO 3308. Microbiology (4).F;S.
Introduction to the biology of microorganisms, including phylogeny and diversity, growth, metabolism, and genetics. A main objective is to gain appreciation and understanding of diversity and ubiquity of microorganisms. The course also considers the role of microorganisms in human's lives, from ways in which they have shaped our environment to direct microbe-human interactions. The laboratory introduces basic techniques of pure culture work, enrichments and isolation, and experimentation with microorganisms. Prerequisites: CHE 1101, CHE 1110, and CHE 1102, CHE 1120. Lecture three hours, laboratory three hours.

BIO 3309. Developmental Biology (4).S.
A study of the fundamental patterns and principles of animal growth and development at the molecular, cellular, and organismal levels. The laboratory will examine the development of selected invertebrates and vertebrates and will include experimental manipulations of developing systems. Lecture three hours, laboratory three hours.

BIO 3310. Marine Sciences (4).S.
A study of the diverse marine habitats throughout the world and the organisms found within these habitats. Various aspects of the cellular, molecular, and developmental biology of marine organisms will be studied. The laboratory will examine selected marine invertebrates and vertebrates will include experimental manipulations. Lecture three hours, laboratory three hours. (WRITING)

BIO 3312. Environmental Studies (3).F;S.
*GEN ED: Junior Writing in the Discipline (WID)*
An in-depth study of environmental problems from a systems/ecological perspective, with emphasis on the scientific basis of the problems and solutions. Topics will vary by semester but will generally include population growth; mineral water and wildlife resources; energy resources; and waste and pollution. Involves significant written assignments. Lecture three hours. Prerequisites: BIO 1802 and ENG 2001 or its equivalent. (WRITING; SPEAKING)

BIO 3314. Comparative Vertebrate Zoology (4).S.
*GEN ED: Junior Writing in the Discipline (WID)*
The origin, evolution, anatomy, physiology, taxonomy, and natural history of vertebrates. Lecture three hours, laboratory three hours. Prerequisites: BIO 1801 and ENG 2001 or its equivalent. (WRITING)

BIO 3320. Air Pollution Effects on Plants and People (3).S.
An in-depth study of the causes and consequences of air pollution throughout the world, including acid deposition, particulates, visibility problems, and gaseous pollutants such as oxides of nitrogen and sulfur, fluorides, ozone, PAN, and carbon dioxide. The sources of these pollutants and their biological effects will be discussed, as well as their interactions with global climate change. Lecture three hours; will include field trips to experimental sites. Prerequisites: BIO 1101 and BIO 1102, and junior level standing. (WRITING; NUMERICAL DATA) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.)

BIO 3436. Introduction to Evolutionary Biology (3).F;S.
An introduction to the study of evolution including a summary of the stratigraphic record, an historical summary of the earth and its major floral and faunal groups, a review of major contributions to evolutionary theory, and a summary of the factors thought to cause evolutionary change. Lecture three hours. (WRITING; SPEAKING; NUMERICAL DATA) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.)

BIO 3500. Independent Study (1-4).F;S.

BIO 3520. Instructional Assistance (1).F;S.
A supervised experience in the instructional process at the University level through direct participation in a classroom situation. Graded on an S/U basis. Prerequisite: junior or senior standing. May be repeated for a total credit of three semester hours.

BIO 3521. Secondary Science Field Experience (1).F;S.
A supervised experience in the instructional process at the secondary school level through direct participation in a classroom situation. Graded on an S/U basis. Prerequisite: junior or senior standing. May be repeated for a total credit of three semester hours. Required of all teacher-licensure candidates in biology.

BIO 3530–3549. Selected Topics (1-4). On Demand.
BIO 3800. Molecular Biology (4).F;S.
*GEN ED: Junior Writing in the Discipline (WID)*
A study of the basic molecular processes and critical recombinant DNA technologies. This includes: structure and general features of the biological information molecules DNA, RNA and proteins; DNA replication and repair processes; RNA synthesis and processing; protein synthesis and regulation; and basic recombinant DNA technology. The laboratory will include: DNA isolation techniques; restriction analysis; construction of a recombinant DNA molecule and cloning; DNA-DNA hybridization; *in vitro* translation and analysis of the protein; PCR amplification of DNA; DNA sequencing and analysis; and the introduction to computer analysis of DNA, RNA and proteins. Lecture three hours, laboratory three hours. Prerequisites: BIO 1801 and one semester of organic chemistry; and ENG 2001 or its equivalent. (WRITING; NUMERICAL DATA; COMPUTER) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.)

BIO 4501. Independent Research (3).F;S.
*GEN ED: Capstone Experience*
A capstone experience in designing and conducting an independent research project. Students will report the results of their study in the form of a paper appropriate for publication in a scientific journal and will present a public seminar on their research. Prerequisites: senior standing, completion of a junior writing course, and permission of the instructor.

BIO 4518. Honors Research (3). On Demand.
Initiation of a research project in the laboratory, field, or classroom under the supervision of a biology faculty member. At least one semester prior to the start of the research project, the student must formally confer with a thesis advisor and must also submit and have approved a formal research proposal. Prerequisite: admission to the Biology Honors Program.

*GEN ED: Capstone Experience*
Work, under the supervision of a biology faculty member, on the project begun in BIO 4518 (Honors Research). An oral report on the project will be presented in a public seminar. A written thesis will be approved by a committee comprised, at minimum, of the thesis advisor and another faculty member. (Note: If a student is using the Biology Honors Thesis to fulfill the requirements for University Honors, one member of the committee must be from outside the Department of Biology.) A student who completes the thesis with a grade of "B" or higher will be eligible for "Honors in Biology." Prerequisite: BIO 4518 with a grade of "B" or higher.

Study of common plants and animals with emphasis on ecology, collecting techniques and identification. Designed for students with limited biology backgrounds. Not open to biology majors for credit. [Dual-listed with BIO 5505.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

BIO 4551. Ornithology (4).S.
The morphology, physiology, behavior, ecology and identification of birds. Early morning field trips are required. Extended field trips to a variety of habitats will be arranged. Lecture and laboratory will emphasize techniques of observing, recording and analyzing data using a research project format. Lecture three hours, laboratory three hours. [Dual-listed with BIO 5551.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

BIO 4552. Entomology (4).F.
A study of the insects, including relevant anatomy for identification and physiology for function, with a special emphasis on the ecological roles of insects and their interaction with other organisms. Evolutionary relationships with related arthropods are also covered. Basic taxonomy of the major insect groups is addressed with a required insect collection, which teaches collecting and preservation techniques. Students are involved in basic experimentation that allows for investigating this very diverse animal group. Lecture three hours, laboratory three hours. [Dual listed with BIO 5552.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

BIO 4555. Plant Physiology (4).F.
A study of the basic principles of plant physiology and fundamental processes such as cell properties, water relations, growth, photosynthesis, respiration, and mineral nutrition. Prerequisites: CHE 1101, CHE 1110 and CHE 1102, CHE 1120. CHE 2201 and CHE 2203 are strongly recommended. Lecture three hours, laboratory three hours. (WRITING; NUMERICAL DATA; COMPUTER) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.) [Dual-listed with BIO 5555.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.
BIO 4556. Mycology (4).F.  
An investigation of the fungi with particular reference to the techniques of working with these organisms. Lecture three hours, laboratory three hours. [Dual-listed with BIO 5556.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

BIO 4557. Ichthyology (4).F.  
This course focuses on the ecology, evolution and diversity of fishes. Aspects of fish physiology and behavior will also be covered along with important conservation issues. In the laboratory, students will have the opportunity to learn how to identify major groups of fishes with emphasis on freshwater species. Lecture three hours, laboratory three hours. [Dual listed with BIO 5557.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

An in-depth study of the fleshy fungi (mushrooms [agarics], chanterelles, hydnums, polypores, and corals) with an emphasis on morphology, systematics, and ecology. Methods of collection, macroscopic and microscopic dissection, identification, and preservation are covered. Field trips are required. Lecture two hours, and laboratory three hours. [Dual-listed with BIO 5558.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

BIO 4559. Mammalogy (4).S.  
The natural history, distribution, adaptations, taxonomy and economic importance of mammals. Field trips and visits to zoos will be arranged. Lecture three hours, laboratory three hours. [Dual-listed with BIO 5559.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

BIO 4560. Herpetology (4).F.  
The history, morphology, systematics, physiology, and distribution of amphibians and reptiles. Methods of collecting, storing, studying and identifying specimens as well as behavioral aspects of species in their natural habitats will be covered. Field trips will be required. Lecture three hours, laboratory three hours. [Dual-listed with BIO 5560.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

BIO 4563. Biology of Aging (3).F.  
General study of biological/physiological changes over time in the structure and function of the systems of organisms with emphasis on the human body. Lecture three hours. [Dual-listed with BIO 5563.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

BIO 4564. Microscopy (4).F.  
A study of the principles and techniques of biological microscopy. Lectures include discussions on preparative techniques for various types of bioimaging, the optical theories behind the imaging technologies, and the structure and function of cellular organelles. Laboratories examine practical techniques of tissue preparation for various kinds of microscopy, the effective use of various types of microscopes, and the interpretation of data obtained from various imaging systems. Lecture three hours, laboratory three hours. [Dual-listed with BIO 5564.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

BIO 4567. Lichenology (3). On Demand.  
A study of the morphology, diversity, evolution, ecology, physiology, and chemistry of lichens as well as their significance as biological indicators. Field trips are required. Lecture two hours, and laboratory three hours. [Dual-listed with BIO 5567.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

BIO 4568. Immunology (4).S.  
A study of the immune system with emphasis on cellular interactions involved in the generation of humoral and cell-mediated immune responses. Lecture includes discussions on inflammation, antibody diversity, tissue transplantation, and immunopathologies. Laboratories examine lymphoid tissue organization, lymphocyte function, and antibody-antigen reactions with emphasis on clinical application. Prerequisite or corequisite: BIO 2400. Lecture three hours, laboratory three hours. [Dual-listed with BIO 5568.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

BIO 4569. Invertebrate Zoology (4).F.  
Students will be introduced to the 34 extant major and minor invertebrate phyla which make up 99% of the Earth's named animal species and virtually 100% of those animals yet undiscovered. The intriguing natural history, symmetry and development, mode of locomotion, nutrition, reproduction, and primary environments of the invertebrates will be discussed. Labs will emphasize invertebrate habitats, field collection, phylogenetic relationships as well as ecological and physiological adaptations and examination of major morphological characteristics. Lecture three hours, laboratory three hours with required field trips. [Dual-listed with BIO 5569.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.
BIO 4570. Parasitology (4).F.
A survey of protistan, helminthic and arthropod parasites with emphasis on organisms of medical and veterinary importance. Lecture three hours, laboratory three hours. [Dual-listed with BIO 5570.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

A study of the associations between insects and plants, using lecture, class discussions and laboratory exercises. Lecture topics include constraints imposed by plants on herbivorous insects and the strategies insects use to overcome them, pollination biology and ecology and the interplay between biotic and abiotic factors in determining interactions. Laboratory exercises are field-based mini-experiments leading to the development of an individual project with experimentation and paper presentation. Lecture three hours, laboratory three hours. [Dual-listed with BIO 5571.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

Basic principles of animal behavior are approached from an evolutionary perspective. Topics such as instinct, learning, biological clocks, sociobiology, communication and physiological mechanisms of behavior are stressed. Laboratory emphasizes techniques of observing, recording, and analyzing behavior using a research project format. Lecture three hours, laboratory three hours. (WRITING; SPEAKING; NUMERICAL DATA) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.) [Dual-listed with BIO 5601.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

BIO 4700. Seminar in Biological Science (3).F;S.
GEN ED: Capstone Experience
A capstone experience in a seminar format. Students will be expected to read seminal articles, monographs, and books from the scientific literature, prepare synthesis papers drawing together ideas from several sources, and present their topics to the seminar group and participate in discussion. Prerequisites: senior standing, completion of a junior writing course, and permission of the instructor.

BIO 4900. Internships in Biology (1-6).F;S.
Practical biological experiences in federal, state, and local agencies. Graded on an S/U basis. [Dual-listed with BIO 5900.] Dual-listed courses require senior standing; juniors may enroll with permission of the department.

BIO 4910. Capstone Internship in Biology (3).F;S.
GEN ED: Capstone Experience
A capstone experience in a commercial/industrial setting, research laboratory, or research facility, or in a federal, state, or local government agency. Students will be expected to complete a significant project developed in conjunction with the cooperating outside facility or agency, will keep a daily journal of their internship experience, and will report the results of their internship in a public seminar. Prerequisites: senior standing, completion of a junior writing course, and permission of the instructor.

GENERAL SCIENCE (GS)

GSP 1010. Contemporary Physics (2).F;S.
GEN ED: Science Inquiry Perspective (Theme: "Contemporary Science")
A course in a series of four science mini-courses for the non-science major. (EACH MINI-COURSE LASTS FOR ONE-HALF SEMESTER. STUDENTS SHOULD BE ADVISED TO REGISTER FOR TWO MINI-COURSES IN ONE SEMESTER TO TOTAL FOUR SEMESTER HOURS.) The course presents a broad view of important areas of contemporary physics. Concepts of modern physics are studied at an introductory level with the necessary classical physics background needed for their comprehension. Co- or prerequisite: a college-level mathematics course. Corequisite: GSC 1020. Contemporary Chemistry. Lecture three hours, laboratory two hours. This course will not satisfy program requirements for students majoring in biology, chemistry, computer science, geology, or physics. (NUMERICAL DATA) (CORE: NATURAL SCIENCES) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.)

GSA 1010. Contemporary Astronomy (2). On Demand.
A course in a series of four science mini-courses for the non-science major. (EACH MINI-COURSE LASTS FOR ONE-HALF SEMESTER. STUDENTS SHOULD BE ADVISED TO REGISTER FOR TWO MINI-COURSES IN ONE SEMESTER TO TOTAL FOUR SEMESTER HOURS.) The course presents a view of how modern astronomers study the universe. The concepts and techniques of modern astronomy are studied at an introductory level with the necessary physics background needed for their comprehension. Co- or prerequisite: a college-level mathematics course. Corequisite: GSC 1020. Contemporary Chemistry. Lecture three hours, laboratory two hours. This course will not satisfy program requirements for students majoring in biology, chemistry, computer science, geology, or physics. (NUMERICAL DATA) (CORE: NATURAL SCIENCES) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.)
GSC 1020. Contemporary Chemistry (2).F;S.
GEN ED: Science Inquiry Perspective (Theme: "Contemporary Science")
A course in a sequential series of four science mini courses. (EACH MINI-COURSE LASTS FOR ONE-HALF SEMESTER. STUDENTS SHOULD BE ADVISED TO REGISTER FOR TWO MINI-COURSES IN ONE SEMESTER TO TOTAL FOUR SEMESTER HOURS.) The course will introduce students to selected fundamental principles and concepts of chemistry discussed and developed in the context of science topics of concern or interest in modern society. Co- or prerequisite: college-level mathematics course. Corequisite: GSC 1010. Contemporary Physics or GSA 1010. Contemporary Astronomy. Lecture three hours, laboratory two hours. This course will not satisfy program requirements for students majoring in biology, chemistry, computer science, geology, or physics. (NUMERICAL DATA) (CORE: NATURAL SCIENCES) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.)

GSG 1030. Contemporary Geology (2).F;S.
GEN ED: Science Inquiry Perspective (Theme: "Contemporary Science")
A course in a sequential series of four science mini-courses. (EACH MINI-COURSE LASTS FOR ONE-HALF SEMESTER. STUDENTS SHOULD BE ADVISED TO REGISTER FOR TWO MINI-COURSES IN ONE SEMESTER TO TOTAL FOUR SEMESTER HOURS.) The course will introduce students to selected fundamental principles and concepts of geology discussed and developed in the context of science topics of concern or interest in modern society. Prerequisite: GSP 1010 or GSA 1010 and GSC 1020. Corequisite: GSB 1040. Contemporary Geology. Lecture three hours, laboratory two hours. This course will not satisfy program requirements for students majoring in biology, chemistry, computer science, geology, or physics. (NUMERICAL DATA) (CORE: NATURAL SCIENCES) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.)

GSB 1040. Contemporary Biology (2).F;S.
GEN ED: Science Inquiry Perspective (Theme: "Contemporary Science")
A course in a sequential series of four science mini-courses. (EACH MINI-COURSE LASTS FOR ONE-HALF SEMESTER. STUDENTS SHOULD BE ADVISED TO REGISTER FOR TWO MINI-COURSES IN ONE SEMESTER TO TOTAL FOUR SEMESTER HOURS.) The course will introduce students to selected fundamental principles and concepts of biology discussed and developed in the context of science topics of concern or interest in modern society. Prerequisites: GSP 1010 or GSA 1010; and GSC 1020. Corequisite: GSG 1030. Contemporary Geology. Lecture three hours, laboratory two hours. This course will not satisfy program requirements for students majoring in biology, chemistry, computer science, geology, or physics. (NUMERICAL DATA) (CORE: NATURAL SCIENCES) (ND Prerequisite: passing the math placement test or successful completion of MAT 0010.)

GS 3500. Independent Study (1-4). On Demand.
GS 3530–3549. Selected Topics (1-4). On Demand.

GS 4403. Teaching Science in Middle and High Schools (3).F;S.
GEN ED: Junior Writing in the Discipline (WID)
This course is for the prospective middle/high school science teacher and it focuses on effective instructional strategies for teaching principles associated with major school science disciplines. Emphasis is placed on planning, science process skills, inquiry-based instruction, hands-on/minds-on activities, improvising materials, demonstrations, and assessment techniques. Special emphasis is also placed on the North Carolina Standard Course of Study and the National Science Education Standards. Secondary education majors will have at least 15 hours of team-taught experience in school classrooms as part of this course. It is STRONGLY ADVISED that all other requirements for licensure (except student teaching) be completed prior to this course. Lecture two hours, laboratory two hours. Prerequisite: ENG 2001 or its equivalent. (WRITING; SPEAKING; COMPUTER)

GS 4404. The Meaning and Nature of Science (3).F.
GEN ED: Junior Writing in the Discipline (WID)
The goal of this course is to help students develop a sound understanding of the nature of science, the process of scientific inquiry, and the reciprocal relationship between science and society through a critical examination of the history of science since the Renaissance. Lecture three hours. Prerequisite: ENG 2001 or its equivalent. (WRITING)