BIOLOGICAL SCIENCES

Our Website (http://www.biol.vt.edu)

Overview

The Department of Biological Sciences offers two B.S. degree paths: the B.S. in Biological Sciences and the B.S. in Microbiology.

The B.S. in Biological Sciences program provides majors with a broad education in the study of life. This curriculum exposes students to the fundamentals of the discipline: genetics, cell and molecular biology, evolutionary biology, and ecology. In addition, Biological Sciences majors may take advantage of elective courses on topics such as macromolecular structure, pathogenic bacteriology, cancer biology, infectious disease ecology, human genetics, and global change ecology. Students may choose to complete an option in one of the following three areas: Biomedical; Ecology, Evolution, and Behavior (EEB); or Biology Education.

The B.S. in Microbiology program provides majors with a more focused education in the biology and roles of microscopic life forms present in our environments. The laboratory-intensive curriculum provides knowledge in the genetics and physiology common to all microbes and allows students to explore specific interests with a broad range of advanced electives such as pathogenic bacteriology, immunology, environmental microbiology, food microbiology, virology, microbial forensics, and bioinformatics.

Modern biology increasingly relies on knowledge, skills, and perspectives associated with other scientific fields, particularly chemistry, mathematics, physics and statistics. Success in biological sciences-associated careers requires students to master the fundamentals of these cognate fields and to be able to apply these skill sets.

As a scientific discipline, biology is more than simple knowledge about living organisms. By integrating education and research, our majors are training to be leaders in their field who practice innovative and interdisciplinary approaches in biological research. By participating in undergraduate research during the academic year, our students are discovering through hands-on experience what it means to Invent the Future. Our majors are strongly encouraged to explore internships and research opportunities on campus and elsewhere during the summer.

The majority of our graduates continue on to advanced studies in the health professions or in various branches of the biological sciences. Graduates pursue professional degrees in medicine, dentistry, veterinary medicine, pharmacy, and nursing, or M.S. or Ph.D. degrees in ecology, environmental biology, microbiology, botany, zoology, cell biology, molecular biology, and biomedical sciences. Students interested in entering the workforce are provided the core background for opportunities in biotechnology, food science, bioinformatics, bio-business, and health-related industries.

Preparation for Advanced Study

Graduate Study

Students who satisfactorily complete the undergraduate curriculum in biological sciences or microbiology may pursue advanced studies leading to the M.S. or Ph.D. in various branches of the biological sciences. Those interested in teaching science are prepared to pursue the M.A.Ed.

Preparation for Medicine

The training afforded by the first three years (approximately 96 hours) meets the pre-medical training requirements of medical colleges that accept students with only three years of undergraduate work. It is strongly recommended, however, that all students complete a B.S. before entering medical school.

Preparation for Dentistry

Dental colleges require a minimum of three years of college training for admission, but it is generally advisable for students to complete the B.S. before entering dental school.

Preparation for Allied Health Professions

Schools of Allied Health Professions, such as nursing, pharmacy, medical technology, physical therapy, etc., require two or more years of college work for admission. Specific requirements are available from Career and Professional Development or the Biological Sciences Department.

Preparation for Veterinary Medicine

Veterinary schools require a minimum of three years of college training for admission. Few students who meet only the minimum entrance requirements are accepted by veterinary schools.

- Biological Sciences Major (https://catalog.vt.edu/undergraduate/college-science/biological-sciences/biological-sciences-bs/)
- Biological Sciences Major with Biology Education Option (https://catalog.vt.edu/undergraduate/college-science/biological-sciences/biological-sciences-bs-biology-education/)
- Biological Sciences Major with Biomedical Option (https://catalog.vt.edu/undergraduate/college-science/biological-sciences/biological-sciences-bs-biomedical/)
- Biological Sciences Major with Ecology, Evolution, and Behavior Option (https://catalog.vt.edu/undergraduate/college-science/biological-sciences/biological-sciences-bs-ecology-evolution-behavior/)
- Microbiology Major (https://catalog.vt.edu/undergraduate/college-science/biological-sciences/microbiology-bs/)
- Microbiology Major with Biomedical Option (https://catalog.vt.edu/undergraduate/college-science/biological-sciences/microbiology-bs-biomedical/)

Head: Daniela Cimini
Harold H. Bailey Endowed Chair: J. R. Walters[6]
Professors: J. Barrett, L. K. Belden, D. Capelluto, C. Carey, R. S. Cohen, C. Finkielstein, M. J. Friedlander, S. Hauf, D. Hawley[2,3,7], A. LaMantia, I. Lazar, L. Li[6], S. B. Melville, I. T. Moore[2,3], D. L. Popham, B. Scharf, A. M. Stevens[2,3,7], D. Tholl, Q. Thomas, B. S. J. Winkel[10], and Z. Yang
Associate Professors: J. Allen, F. Aylward, B. Brown, J. Chen, V. Corbin, J. Draghi, E. R. Hotchkiss[2,7], S. Kojima, K. Langwig, J. W. McGlothlin, M. C. Mims, F. Schubot, K. Sewall, J. Smyth, J. C. Uyeda, R. A. Walker[3,7], and S. R. Whitehead
Assistant Professors: D. Cortes Estrada, V. Gómez-Bahamón, A. D. Gray, J. Hoyt, B. Hsu, A. Igwe, S. R. Johnstone, H. Lam, R. Márquez Pizano, J. Moss, A. Suvorov, and J. Vargas-Muñiz
Assistant Professor of Practice: J. G. Tokuhisa
Senior Instructors: J. Evans[1], E. P. Hogan, M. V. Lipscomb[2,3], M. S. Rosenzweig[2,3,4], and R. W. Seyler
Advanced Instructors: M. M. Emori[2,4], S. M. Voshell, and B. D. Wills
Instructor: K. A. Bretz
Curator of the Massey Herbarium: J. S. Metzgar

Footnotes:

1 Award for Excellence in Undergraduate Advising
2 Academy of Teaching Excellence inductee
3 Wine Award recipient
4 Sporn Award recipient
5 Alumni Award for Extension Excellence
6 Alumni Award for Research Excellence
7 Alumni Award for Teaching Excellence
8 Academy of Faculty Service
9 Commonwealth of Virginia Outstanding Faculty Award
10 Diggs Teaching Scholar Awards

Undergraduate Course Descriptions (BIOL)

BIOL 1004 - Biology Orientation Seminar (1 credit)
An introduction to academic and career planning for majors in Biology and students who may be considering Biology as a major.
Instructional Contact Hours: (1 Lec, 1 Crd)

BIOL 1014 - Introduction to Biology (3 credits)
Introductory biology for non-life science majors. Topics covered include the hierarchy of living systems, cell structure, physiology, and reproduction, Mendelian genetics, molecular genetics, evolution, microbial diversity, plant anatomy and physiology, animal anatomy and physiology, and ecological systems. Ethical aspects of current research in these areas. Partially duplicates 1005, 1006, 1105, 1106.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1024 - Cancer: Causes, Treatments, Costs (3 credits)
Introduction to risk factors and biological mechanisms associated with cancer. Current approaches to cancer prevention, diagnosis, and treatment. Personal, socioeconomic, and global aspects of cancer.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1034 - Biology of Sex (3 credits)
Sexual reproduction in living organisms from a scientific perspective including morphology, physiology, behavior, development and evolution. Biological basis and ethical considerations of human societal issues including contraception, homosexuality, and gender/sex.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1054 - Human Biology: Concepts and Current Issues (3 credits)
Survey of human biology, including physiology, genetics, evolution, and ecology. Focus on homeostasis, including factors and choices that disrupt homeostasis and health. Examination of technological advances and ethical issues associated with the biology of humans. Personal and societal choices that impact human ecology.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1064 - Plants and Civilization (3 credits)
Survey of basic plant biology. Critical roles of plants as food, drugs, textiles, other products. Examination of the global, historical, and cultural links between plants and humans. Discussion of current topics, including biotechnology, global change, biodiversity loss, nutrition and drug addiction.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1074 - How Animals Think (3 credits)
Overview of scientific research on animal cognition and behavior from perspectives in biology, psychology, and neuroscience. Study and application of scientific approaches to the study of animal cognition and behavior in the context of personal, political, and societal decision making. Considers the influence of animal cognition and animal ethics on decisions about human-animal interactions at a personal and societal scale ranging from decisions about food supply to conservation. Provides the framework to evaluate animal personality, emotion, consciousness, and rights. Addresses how cultural, social and political views influence scientific research on animal cognition. Consideration of bidirectional effects of human-animal interactions on One Health and animal welfare.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1105 - Principles of Biology (3 credits)
Introduction to the science of biology. 1105: living systems; biological molecules; cell structure, function, and reproduction; cellular energetics and metabolism; expression and inheritance of genetic information; evolution; ethical implications of research and discovery in these areas. 1106: animal and plant anatomy and physiology, ecology, and animal behavior; ethical implications of research and discovery in these areas. (1105 duplicates 1005, 1014; 1106 duplicates 1006, 1014. Credit for 1014 will be disallowed if 1105 or 1106 are taken after earning credit for 1014)
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1106 - Principles of Biology (3 credits)
Introduction to the science of biology. 1105: living systems; biological molecules; cell structure, function, and reproduction; cellular energetics and metabolism; expression and inheritance of genetic information; evolution; ethical implications of research and discovery in these areas. 1106: animal and plant anatomy and physiology, ecology, and animal behavior; ethical implications of research and discovery in these areas. (1105 duplicates 1005, 1014; 1106 duplicates 1006, 1014. Credit for 1014 will be disallowed if 1105 or 1106 are taken after earning credit for 1014).
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1115 - Principles of Biology Laboratory (1 credit)
Emphasizes biological principles through investigative exercises and collaborative learning. 1115: cell chemistry, physiology and reproduction and genetics; 1116: plant and animal form and function, and ecology. Primarily for students majoring in the life sciences. (Duplicates 1015 1016, 1125, 1126).
Corequisite(s): BIOL 1105
Instructional Contact Hours: (3 Lab, 1 Crd)

BIOL 1116 - Principles of Biology Laboratory (1 credit)
Emphasizes biological principles through investigative exercises and collaborative learning. 1115: cell chemistry, physiology and reproduction and genetics; 1116: plant and animal form and function, and ecology. Primarily for students majoring in the life sciences.
Corequisite(s): BIOL 1106
Instructional Contact Hours: (3 Lab, 1 Crd)

BIOL 1135 - Phage Hunters (2 credits)
Isolation, identification, and characterization of bacteriophages from environmental sources. 1135: Bacteriophage DNA purification, genomic analysis, imaging, and sequencing. 1136: Bioinformatic characterization and annotation of sequenced bacteriophage genomes, comparative genomic analysis, submission of bacteriophage sequence data to public databases.
Instructional Contact Hours: (6 Lab, 2 Crd)

BIOL 1136 - Phage Hunters (2 credits)
Isolation, identification, and characterization of bacteriophages from environmental sources. 1135: Bacteriophage DNA purification, genomic analysis, imaging, and sequencing. 1136: Bioinformatic characterization and annotation of sequenced bacteriophage genomes, comparative genomic analysis, submission of bacteriophage sequence data to public databases.
Prerequisite(s): BIOL 1135
Instructional Contact Hours: (6 Lab, 2 Crd)

BIOL 1214 - Careers in Medicine (1 credit)
For students considering a career in health care. Investigation of various health care professions, including requirements for additional education and the professional and personal expectations characteristic of these professions. Introduction to biomedical ethics and health policy. Options for financing professional school. How to become a competitive applicant.
Instructional Contact Hours: (1 Lec, 1 Crd)

BIOL 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 2004 - Genetics (3 credits)
Mendelian transmission, chromosome behavior and organization, gene and chromosome mutation, genetic properties of nucleic acids, gene expression and development, DNA technology.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106 and (CHEM 1036 or CHEM 1056 or CHEM 1056H or CHEM 1016 or ISC 2105)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2124 - Cell and Molecular Biology for Engineers (2 credits)
Composition, structure and function of cells; fundamentals of gene expressions, cell physiology, cellular movement and reproduction; stem cells and tissue formation; synthetic biology and applied cell and molecular biology. Not for Biological Sciences majors.
Prerequisite(s): ENGR 2164 or COS 2164
Instructional Contact Hours: (2 Lec, 2 Crd)

BIOL 2134 - Cell Function and Differentiation (3 credits)
Fundamental mechanisms essential for cell function. Methods used to study cells. Cellular structure and physiology, energy production, cell survival and reproduction. Cell interactions and communication, stem cells, cell differentiation, tissue formation.
Prerequisite(s): BIOL 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2304 - Plant Biology (3 credits)
Introductory botany. Form, growth, function, reproduction, and ecological adaptations of major groups of plants.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HORT 2304

BIOL 2404 - Biotechnology in A Global Society (3 credits)
Introduction to the world-wide impact of biotechnology and molecular biology, including applications to plants, animals, and microorganisms. Explores basic concepts of genetic engineering, scientific and ethical issues, and public concerns related to biotechnology. Topics include: environmental release of genetically engineering organisms, bioremediation, safety of genetically engineered food products, transgenic plants and animals, gene therapy, and genetic screening.
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H) and CHEM 1015 and CHEM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALS 2404

BIOL 2504 - General Zoology (3 credits)
Morphology, features, adaptations, and ecology of major animal groups, emphasizing major patterns of evolutionary change.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2604 - General Microbiology (3 credits)
Microbial structure, function, metabolism, genetics and ecology. The role of microorganisms in host/parasite relationships will be emphasized.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106 and (CHEM 1036 or CHEM 1056 or CHEM 1056H or ISC 2105)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2614 - General Microbiology Laboratory (1-2 credits)
Introduction to microbiological techniques and procedures. Aseptic technique and safe handling. Culture, characterization, and identification of microorganisms.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106 and (CHEM 1036 or CHEM 1056 or CHEM 1056H or ISC 2105)
Corequisite(s): BIOL 2604
Instructional Contact Hours: (2-4 Lab, 1-2 Crd)

BIOL 2704 - Evolutionary Biology (3 credits)
Evolutionary mechanisms, systematic principles, and theories of the origin and evolution of life.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2804 - Ecology (3 credits)
Fundamental interaction of organisms with the biotic and abiotic components of ecosystems. Topics will include: physical environment and organismic interactions, concepts of population ecology and community ecology, ecosystems interactions, and environmental problems.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

BIOL 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 2984D - Special Study (1-19 credits)
Pathway Concept Area(s): 4 Reasoning in Natural Sci.
Instructional Contact Hours: Variable credit course

BIOL 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 3014 - Insect Biology (2 credits)
Insect biology provides an introduction to the science of entomology. The course covers the diversity of insects, their biology and behavior, the importance of insects and insect control programs in agriculture, and the effects that insects have had on human history and culture. Laboratory (3024) is optional.
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H)
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: ENT 3014

BIOL 3024 - Insect Biology Laboratory (2 credits)
Taxonomy and ecology of insects commonly encountered. Identification of all orders and many common families. Ecological attributes of each taxon, including food, habitat, life cycle, and behavior. An insect collection is required.
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H)
Corequisite(s): BIOL 3014
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)
Course Crosslist: ENT 3024

BIOL 3104 - Cell and Molecular Biology Laboratory (1 credit)
Introduction to methods used to study prokaryotic and eukaryotic cells. Recombinant DNA, protein expression and purification, the polymerase chain reaction, bioinformatics, and microscopy.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lab, 1 Crd)

BIOL 3134 - Human Genetics (3 credits)
Principles of genetic analysis in humans with emphasis on genetic diseases of humans; methods of karyotyping human chromosomes; methods of pedigree and genetic analysis of humans; principles, techniques, and analysis of twin studies in humans; techniques used to identify and characterize normal and abnormal chromosomes; principles and methods of DNA fingerprint analysis of humans.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 3204 - Plant Taxonomy (3 credits)
Systematic survey of vascular plants, emphasizing identification, terminology, classification, evolutionary relationships.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BIOL 3254 - Medical and Veterinary Entomology (3 credits)
An introduction to the roles of insects and other arthropods in the direct causation of disease in humans and animals, and as vectors in the transmission of disease organisms. The epidemiology and replication cycles of vector-borne pathogens with major medical and veterinary importance will be examined. Information will be provided on the biology and behavior of disease vectors and external parasites, and on the annoying and venomous pests of humans and animals. Mechanisms of control will be discussed
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 or (BIOL 1205H and BIOL 1206H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENT 3254

BIOL 3264 - Medical and Veterinary Entomology Laboratory (1 credit)
Taxonomy and anatomy of insects and arthropods of medical and veterinary importance. Examination of feeding behavior and ecology. Emphasis on the mechanism of injury or pathogen transmission by each group.
Prerequisite(s): (BIOL 1105 and BIOL 1106) or (BIOL 1005 and BIOL 1006) or (BIOL 1205H and BIOL 1206H)
Corequisite(s): BIOL 3254
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: ENT 3264

BIOL 3404 - Introductory Animal Physiology (3 credits)
A comparative systems level approach to the physiology of animals, emphasizing vertebrates: metabolic, temperature, osmotic, and ionic regulation; function of respiratory, circulatory, digestive, muscle, nervous, and locomotory systems; endocrine regulation and biological rhythms. Must have prerequisites or instructors permission.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 3454 - Introductory Parasitology (4 credits)
Ecology, taxonomy, morphology, life cycles, pathogenesis, and host-parasite relationships of parasitic eukaryotes.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 3514 - Introduction to Histology (3 credits)
Overview of tissue structure and function in the human body; microscopic examination of tissue sections; organization of tissues in different organ systems; histopathology of tissues and organs.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BIOL 3604 - Food Microbiology (4 credits)
Role of microorganisms in foodborne illness, food quality, spoilage, and preservation. Control of microorganisms in foods. Methods to enumerate, identify, and characterize microorganisms in foods.
Prerequisite(s): BIOL 2604 and BIOL 2614
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: FST 3604

BIOL 3764 - Careers in Microbiology (3 credits)
Contemporary research topics in microbiology, methods of research data analysis, the research publication process, research presentation and interview skills, career paths for microbiology graduates, preparation for graduate school, preparation for entry into the job market.
Prerequisite(s): BIOL 2604
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 3774 - Molecular Biology (3 credits)
Advanced study of the molecular biology of prokaryotic and eukaryotic cells, including mechanisms of gene expression and regulation, relative merits of experimental model systems, and practical applications in agriculture and medicine.
Prerequisite(s): BIOL 2134 or ALS 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 3804 - Principles of Biology Teaching Assistant (2 credits)
For undergraduate teaching assistants (UTAs) facilitating BIOL 1105 or 1106 class sections that utilize active-learning pedagogies and require facilitation of in-class learning activities. Content and practice of teaching strategies and professionalism in the classroom. Supervision by departmental faculty or staff. Selection by Principles of Biology instructional team. May be repeated four times with different content for a maximum of eight credits. Junior Standing, overall minimum GPA of 3.0.
Prerequisite(s): BIOL 1105 and BIOL 1106
Instructional Contact Hours: (6 Lab, 2 Crd)
Repeatability: up to 8 credit hours

BIOL 3814 - Careers In Biological Sciences (1 credit)
Exploration of career opportunities in the biological sciences, including employment and further education. Professional development activities, including resumes, career fairs, networking, preparation for interviews, ethics, and assessment and comparison of job offers. Does not count for Biological Sciences or Microbiology elective credit. Pre: junior standing
Instructional Contact Hours: (1 Lec, 1 Crd)

BIOL 3954 - Study Abroad (1-6 credits)
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)

BIOL 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 4004 - Freshwater Ecology (4 credits)
Interactions of physical, chemical, and biological properties of freshwater ecosystems.
Prerequisite(s): BIOL 2804 or BIOL 2804H
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 4014 - Environmental Toxicology (2 credits)
Discussion of ecotoxicological and philosophical issues in the development of standards for control of toxic chemicals in freshwater, including site-specific examples, application of current control methods, recovery of damaged ecosystems, and government regulations.
Prerequisite(s): BIOL 2804
Instructional Contact Hours: (2 Lec, 2 Crd)

BIOL 4104 - Developmental Biology (3 credits)
Morphological, physiological, and molecular events in embryological and developmental systems, including regulation at the level of transcription, translation, and enzyme or hormone activation.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4114 - Global Change Ecology (3 credits)
Effects of human alteration of climate, landscapes and biogeochemical cycling on ecological structure and functioning at the global scale. Influence of global changes on ecosystem processes and biodiversity with paleo- and contemporary examples. Current and future potential feedbacks between biological systems and the global environment.
Prerequisite(s): (BIOL 2704 or BIOL 2704H) and BIOL 2804
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4134 - Evolutionary Genetics (3 credits)
Genetic variation, Hardy-Weinberg equilibrium, agents of change in gene frequencies, molecular evolution, mechanisms of speciation. Comparison of theoretical models with natural and laboratory populations.
Prerequisite(s): BIOL 2004 and (BIOL 2704 or BIOL 2704H)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4164 - Environmental Microbiology (3 credits)
Ecology, physiology, and diversity of soil and aquatic microorganisms; incorporates the significance of these topics within the context of environmental applications such as bioremediation, wastewater treatment, control of plant- pathogens in agriculture, and pollution abatement in natural systems. The laboratory portion of the course will stress methodology development, isolation and characterization of microorganisms from natural and engineered systems, and examination of the roles of microorganisms in biogeochemical cycling.
Prerequisite(s): BIOL 2604
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: ENSC 4164

BIOL 4204 - Advanced Principles of Biology Teaching Assistant (3 credits)
For experienced Principles of Biology Undergraduate Teaching Assistants (UTAs) facilitating instruction of BIOL 1105 or 1106 class sections that utilize active-learning strategies. Collaboratively plan, present, and run activities to train first-time UTAs in the skills needed to support student success in the Principles of Biology classroom. Prepare first-time UTAs to guide active learning exercises, facilitate student teamwork, communicate scientific information, respond to student questions, provide feedback on student activities, and promote student engagement. Model professional and ethical conduct. Enrollment requires approval of Principles of Biology instructional team. May be repeated three times with different content for a maximum of nine credits. Pre: Senior standing.
Prerequisite(s): BIOL 3804
Instructional Contact Hours: (9 Lab, 3 Crd)
Repeatability: up to 9 credit hours

BIOL 4304 - Field Ecology (4 credits)
Student-centered, hands-on experience in ecological research. Field experiences in local ecosystems, including weekend field trips. Development of research questions and design of independent projects. Data collection, data management, statistical analysis and data visualization, interpretation of empirical evidence. Ethical considerations for collaborative research. Communication of results through oral presentations and scientific writing.
Prerequisite(s): BIOL 2804 and STAT 3615
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 4314 - Plant Ecology (4 credits)
Introduction to ecology of terrestrial plants including major plant functional types, ecophysiological aspects of functional types, molecular plant ecology, behavior of populations, responses of plant communities to disturbance, and vegetation analysis. Laboratory covers methods for measuring and analyzing natural vegetation, and setting up field and greenhouse experiments.
Prerequisite(s): (BIOL 2304 or BIOL 2804 or FOR 3314) or HORT 2304
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 4334 - Chemical Ecology (3 credits)
Chemical interactions between organisms with emphasis on the plant biosphere. Fundamental concepts, theories, and general methodology of chemical ecology: mechanisms of chemically- mediated interactions; and engineering of natural chemical defenses in sustainable agriculture.
Prerequisite(s): (BIOL 2304 or BIOL 2804 or FOR 2314 or BCHM 4115) and CHEM 1035
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4354 - Aquatic Entomology (4 credits)
Biology and taxonomy of insects and other macroinvertebrates most commonly encountered in freshwater environments. Selected aspects of biology, such as habitat, feeding, locomotion, and life history. Identification of individual taxa, mostly at family and genus level. Significance of these organisms in aquatic ecology, pollution monitoring, and natural resource management.
Prerequisite(s): (BIOL 1005 and BIOL 1006) and (BIOL 1015 and BIOL 1016) or (BIOL 1105 and BIOL 1106 and BIOL 1115 and BIOL 1116)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: ENT 4354

BIOL 4404 - Ornithology (4 credits)
Biology of birds, including functional anatomy, systematics, evolutionary history, behavior, and ecology. Laboratory on systematics, anatomy, and field experience in the areas of behavior and ecology.
Prerequisite(s): BIOL 2804
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 4454 - Invertebrate Zoology (4 credits)
Identification, morphology, evolutionary relationships, and natural history of free-living invertebrates, excluding insects.
Prerequisite(s): BIOL 2504
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 4474 - Behavioral Ecology (3 credits)
Ecological and evolutionary bases of animal behavior. Emphasis on wild animals in natural environments. Genetic, developmental, neurobiological, and physiological mechanisms of animal behavior. How animals find food, move, communicate, reproduce, and care for young. Applications of behavioral ecology to human behavior.
Prerequisite(s): BIOL 2504 or BIOL 2804
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4484 - Freshwater Biomonitoring (4 credits)
Concepts and practices of using macroinvertebrates and fish to monitor the environmental health of freshwater ecosystems. Effects of different types of pollution and environmental stress on assemblages of organisms and underlying ecological principles. Role of biological studies in environmental regulation. Study design, field and laboratory methods, data analysis and interpretation, verbal and written presentation of results.
Prerequisite(s): (BIOL 2804) and (BIOL 4004 or BIOL 4354 or ENT 4354 or FIW 4424 or FIW 4614)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: ENT 4484, FIW 4484

BIOL 4554 - Neurochemical Regulation (3 credits)
Neurochemical transmission within the vertebrate brain will be examined. Emphasis will be placed on the chemical coding underlying the control of various behaviors and how these systems can be modified by various drugs or diet.
Prerequisite(s): (ALS 2304 or BIOL 3404) and CHEM 2535
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALS 4554

BIOL 4564 - Infectious Disease Ecology (3 credits)
Principles of infectious disease dynamics from ecological and evolutionary perspectives. Examines a variety of wildlife hosts and disease-causing agents (bacteria, viruses, and parasites) using the framework of agent-host- environment interactions. Selective coverage of specific host and pathogen models to illustrate underlying principles of wildlife disease emergence, maintenance, and spread, as well as connections between wildlife and human health.
Prerequisite(s): (BIOL 2704 or BIOL 2704H) and (BIOL 2804 or BIOL 2804H)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4574 - Social Behavior of Birds and Mammals (3 credits)
This course examines origins, influences and implications of social behavior in a variety of avian and mammalian species. Emphasis is placed on understanding group organization and dynamics in inter and intra-species situations. Experimental data from several disciplines (e.g., genetics, physiology, biochemistry) are reviewed to demonstrate their associations with behavioral adaptive mechanisms. Avian and mammalian species living in wild, zoo, agricultural companion and laboratory settings are discussed.
Prerequisite(s): BIOL 1106 and ALS 3104 or BIOL 2004
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALS 4574

BIOL 4594 - Ecology, Evolution, and Behavior Senior Seminar (3 credits)
Review and discussion of contemporary research areas and global challenges addressed in publications in ecology, evolution, and behavior, the research process, methods for communicating science to professional and non-professional audiences, professional development for careers in ecology, evolution, and behavior, diversity and equity in the sciences.
Prerequisite(s): BIOL 2704 and BIOL 2804
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4624 - Microbial Genetics (3 credits)
Molecular genetics of bacteria and their associated plasmids and phages.
Prerequisite(s): BIOL 2004 and (BIOL 2604 or BIOL 2604H)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4634 - Microbial Physiology (3 credits)
The study of the structure, function and metabolic activities of prokaryotic microorganisms. Topics covered included cell composition and growth, metabolic unity and diversity, patterns of regulation, transport mechanisms, environmental sensing and response and cellular differentiation processes. (BIOL 4624 is recommended, but not required.)
Prerequisite(s): BIOL 2134 and (BIOL 2604 or BIOL 2604H) and BIOL 2614
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4644 - Microbial Molecular Genetics and Physiology Laboratory (3 credits)
Introduction to classical and molecular methods used for the study of bacterial genetics and physiology. Laboratory exercises cover analysis of patterns of gene regulation; assay of enzymatic activities; mutagenesis followed by selection, screening, and physiological characterization of mutant strains; genome database utilization; and large scale fermentation.
Prerequisite(s): BIOL 2134 and (BIOL 2604 or BIOL 2604H) and BIOL 2614
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

BIOL 4664 - Virology (3 credits)
Classification, structure, pathogenesis, host response, and replication strategies of viruses of bacteria, plants, and animals, stressing mechanisms elucidated by molecular biological techniques.
Prerequisite(s): BIOL 2134 and (BIOL 2604 or BIOL 2604H) and BIOL 2614
Instructional Contact Hours: (2 Lec, 1 Lab, 3 Crd)

BIOL 4674 - Pathogenic Bacteriology (3 credits)
Characteristics of bacteria that cause human disease, nature of infectious processes, virulence factors, epidemiology, resistance, immunization.
Prerequisite(s): BIOL 2134 and (BIOL 2604 or BIOL 2604H) and BIOL 2614
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4684 - Microbiomes (3 credits)
Landmark and current research on human microbiomes. Factors that influence the gut microbiome, and the role of the gut microbiome in disease. Other microbiomes of the human body. Bacteriophages and the ecology of microbiomes. Application of technologies to engineer microbiomes.
Prerequisite(s): BIOL 2004 and BIOL 2604 and (BCHM 3114 or BCHM 4115)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4704 - Immunology (3 credits)
Immunochemistry of antigens and antibodies, serological reactions, chemistry of complement, control of immunity, immune response of an intact animal.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4714 - Immunology Laboratory (1 credit)
Serological and immunobiological techniques used to interpret the consequences of an immune response.
Prerequisite(s): BIOL 2134
Corequisite(s): BIOL 4704
Instructional Contact Hours: (3 Lab, 1 Crd)

BIOL 4724 - Pathogenic Bacteriology Lab (2 credits)
Microbiological techniques used to identify and characterize bacteria that cause infectious disease.
Prerequisite(s): BIOL 2134 and (BIOL 2604 or BIOL 2604H) and BIOL 2614
Corequisite(s): BIOL 4674
Instructional Contact Hours: (4 Lab, 2 Crd)

BIOL 4734 - Inflammation Biology (3 credits)
Cellular and molecular pathways controlling human responses to inflammatory challenges. Regulation of immune cells during inflammation. Interaction of host cells and tissues with environmental risk factors that cause inflammation. Pathogenesis of inflammatory diseases including cardiovascular diseases, diabetes, multi-organ failure, aging, neurological diseases and sepsis. Therapeutic intervention of inflammatory diseases.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4774 - Molecular Biology Lab (3 credits)
An introduction to recombinant DNA methods, including restriction endonuclease digestion, gel electrophoresis, cloning, Southern blotting, polymerase chain reaction, sequencing and analysis of reporter gene expression in transgenic organisms. BIOL 3774 may be taken as a corequisite with 4774.
Prerequisite(s): BIOL 3774
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

BIOL 4804 - Prokaryotic Diversity (3 credits)
The study of the vast array of physiological, morphological, and behavioral properties of prokaryotes. Topics include: modern prokaryotic classification, prokaryotic diversity, relationship and importance to cell and molecular biology and biochemistry, application and use in industry and agriculture, and to the maintenance of the biosphere. Must have pre-requisites or consent of the instructor.
Prerequisite(s): (BIOL 2604 or BIOL 2604H) and BIOL 2614 and (BIOL 3124 or BIOL 4634 or BCHM 3114)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4824 - Bioinformatics Methods (3 credits)
Application of bioinformatics methods in biological research. Methods to access bioinformatics data. Theory and methods for analysis of DNA sequences, and analysis of complex data sets including whole genome sequences and gene expression data. Use of standard bioinformatics software and databases.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BIOL 4834 - Practical Analysis of Protein Structure and Function (3 credits)
Application of biophysical and biomechanical methods to characterization of protein structure and function, macromolecular interactions and conformational changes. Strategies, experimental design, practical considerations, troubleshooting, data analysis.
Prerequisite(s): BIOL 2134 and (CHEM 2536 or CHEM 2566) and (PHYS 2206 or PHYS 2306)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BIOL 4844 - Proteomics and Biological Mass Spectrometry (3 credits)
Introduction to mass spectrometry (MS) instrumentation and advanced proteomic methods for systems biology applications. Peptide mass fingerprinting, tandem MS, quantitation, phospho/glyco proteomics, and bioinformatics tools for evaluation and interpretation of mass spectrometry data.
Prerequisite(s): BIOL 2134 and CHEM 2535 and PHYS 2205
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4854 - Cytogenetics (3 credits)
Structure and function of eukaryotic chromosomes, with emphasis on (i) use of model systems to study specific chromosome substructures or functions; (ii) techniques used to identify and classify both normal and aberrant chromosomes; and (iii) diseases caused by defective chromosome structure and/or function.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4864 - Clinical Biology (3 credits)
Biological basis, development and symptoms of selected human diseases. Pharmacological approaches to treating disease. Review and interpretation of clinical cases. Approaches to working with patients: the interview, physical examination and clinical history. Use of diagnostic tests and treatments. Clinical trials of potential therapeutic interventions.
Prerequisite(s): BIOL 2134 and (BCHM 3114 or BCHM 4115)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4874 - Cancer Biology (3 credits)
The molecular and cellular basis of cancer, including viral and cellular oncogenes, tumor suppression mechanics, cellular immortality, genomic integrity, angiogenesis, metastasis, and traditional and developing therapies.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4884 - Cell Biology (3 credits)
Advanced study of the inner workings of eukaryotic cells, including membrane structure and function, protein secretion, the cytoskeleton, cell cycle control and intercellular communication.
Prerequisite(s): BIOL 3774 or BCHM 4116
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

BIOL 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

BIOL 29844 - Special Study (1-18 credits)
Pathway Concept Area(s): 4 Reasoning in Natural Sci.
Instructional Contact Hours: (1-18 Lec, 1-18 Crd)