

Biological Sciences (BIOS)

Courses

BIOS 010 Bioscience in the 21st Century 3 Credits

A multidisciplinary survey of advances in bioscience. Exploration of theme-based topics (e.g., infectious diseases, cancer, genome-based medicine, engineered biomedical systems) coupled with social/ethical considerations. Three lectures per week. Participation in online multidisciplinary discussion, writing assignments, field trips, and/or other activities.

Attribute/Distribution: NS, NW

BIOS 032 (EES 032) Oceanography 3 Credits

An introduction to the structure, composition, and processes of the earth from a marine perspective. Topics include earth structure, plate tectonics, continental margins, coastal processes, seawater chemistry, ocean circulation, wave dynamics, primary productivity, plankton and plants, marine organisms and communities. May be combined with EES 022 or EES 004 for 4 credits.

Attribute/Distribution: NS, NW

BIOS 041 Introduction to Cellular and Molecular Biology 0,3 Credits

Basic building blocks and higher order structures required for cellular processes. Topics include the character of membranes, the molecular/cellular basis of energy production, cell cycle progression, DNA replication, gene expression, basic Mendelian genetics, signal transduction, and cell division.

Prerequisites: CHM 075 or CHM 025 or CHM 030 or CHM 040

Can be taken Concurrently: CHM 075, CHM 025, CHM 030, CHM 040

Attribute/Distribution: NS, NW

BIOS 042 Introduction to Cellular and Molecular Biology Laboratory 1 Credit

Techniques and experiments related to the principal topics covered in BIOS 041; emphasis on experimental design and scientific communication.

Prerequisites: BIOS 041

Can be taken Concurrently: BIOS 041

Attribute/Distribution: NS, NW, W

BIOS 043 Phage Hunting Laboratory 2 Credits

The first laboratory research course in a two-semester series (as part of the Howard Hughes Medical Institute's SEA-PHAGES Program) that focuses on the isolation (from local soil), as well as the physical and genomic characterization of novel bacteriophages that infect mycobacteria. Course will substitute for BIOS 42. Application and acceptance into Lehigh's SEA program required (see www.lehigh.edu/~insea); freshman status in the spring semester or permission of the instructor. Co-requisite: BIOS 41 or instructor permission.

Prerequisites: BIOS 041

Can be taken Concurrently: BIOS 041

Attribute/Distribution: NS, Q

BIOS 044 Introduction to Integrative and Comparative Biology 0,3 Credits

Experimental and historical approaches to the analysis of structural and functional properties in organisms. Use of scientific method to study species diversity. Introduction to the analysis of organismal attributes that explain behavioral repertoire and ecological relationships. **Prerequisites:** BIOS 041 and (BIOS 042 or BIOS 043).

Prerequisites: BIOS 041 and (BIOS 042 or BIOS 043)

Attribute/Distribution: CC, NS

BIOS 045 Introduction to Integrative and Comparative Biology Laboratory 1 Credit

Experiments and discussions related to the topics covered in BIOS 044; emphasis on experimental design and scientific communication.

Prerequisites: BIOS 044

Can be taken Concurrently: BIOS 044

Attribute/Distribution: LS, NS, Q

BIOS 115 Genetics 0,3 Credits

The structure, function, and continuity of hereditary information. Classical genetic analysis. Molecular biology of genes and genomes. Population genetics and evolution. Genetics of complex traits.

Prerequisites: BIOS 041

Attribute/Distribution: NS

BIOS 116 Genetics Laboratory 1 Credit

Introduction to model organisms; techniques used in molecular genetics; experimental design and scientific communication.

Prerequisites: BIOS 115

Can be taken Concurrently: BIOS 115

Attribute/Distribution: NS

BIOS 118 Phage Genetics Laboratory 2 Credits

Part of a 2-semester series focusing on genetic analysis of novel bacteriophage genomes to determine gene function using recombinering strategies. Phage genome annotation using bioinformatics for previously sequenced phage genomes. Additional genetics, molecular biology, and/or biochemical research on previously isolated bacteriophages may also be included.

Prerequisites: BIOS 115

Can be taken Concurrently: BIOS 115

Corequisites: BIOS 115

Attribute/Distribution: NS, W

BIOS 130 (MATH 130) Biostatistics 0,4 Credits

Elements of statistics and probability theory with emphasis on biological applications. Statistical analysis of experimental and observational data.

Prerequisites: MATH 052 or MATH 022 or MATH 032

Attribute/Distribution: Q

BIOS 161 Supervised Research 1-3 Credits

Apprenticeship in ongoing faculty research program. Literature review, experimental design, data collection and analysis, and professional writing under faculty sponsor supervision. Only 3 credits can be counted toward any life science major. Consent of instructor required.

Repeat Status: Course may be repeated.

Prerequisites: BIOS 041

Attribute/Distribution: NS

BIOS 202 Biomedical Externship 0-3 Credits

Analysis of individualized experiences at external biomedical clinical or research sites. Limited enrollment. May not be taken for pass/fail grading. May not be used to satisfy any life science major or minor requirement. Consent of department chair required.

Attribute/Distribution: NS

BIOS 218 SEA-GENES Laboratory 2 Credits

A third semester extension of the SEA-PHAGES lab experience. A course-based research experience with goals established by the Howard Hughes Medical Institute - the cloning of all genes of a chosen bacteriophage, the testing of the functions of individual bacteriophage genes by phenotypic assays, the identification of host proteins that physically interact with a limited subset of bacteriophage proteins - the ultimate goal of which is establishing a complete data set for the chosen bacteriophage.

Prerequisites: BIOS 043 and BIOS 118

Attribute/Distribution: NS

BIOS 234 Comparative Vertebrate Anatomy 4 Credits

A course in vertebrate zoology with emphasis on the study of homologous body structures in the various vertebrate classes and their relationship to the functional demands of habit and environment in each class. Detailed dissections of representative vertebrates are made in the laboratory. Two lectures and two laboratory periods.

Prerequisites: BIOS 044 and BIOS 045

Attribute/Distribution: NS

BIOS 235 Human Physiology 3 Credits

The goal of this course is to provide students with a thorough understanding of the major systems of the human body. Students will examine many of the major body systems including Nervous, Muscular, Cardiac, Respiratory, and Digestive systems. These systems will be analyzed by their components at both the cellular and molecular level. Students will also examine how each system functions as a whole and how it interacts with other systems at the organismal level.

Prerequisites: BIOS 044

Attribute/Distribution: NS

BIOS 237 (BIOC 237) Introductory Molecular Modeling and Simulation 3 Credits

Key concepts, methods, and tools used in molecular modeling and simulation. A hybrid lecture/hands-on practice course using the lectures and tools in CHARMM-GUI (<http://www.charmm-gui.org/> lecture). Topics include (but not limited to) UNIX operating system, text editors, Python programming, scientific programming using Python, PDB (Protein Data Bank), molecular mechanics, minimization, molecular dynamics, Monte Carlo simulation. The understanding of these concepts and algorithms as well as their applications to well-defined practical examples involving currently important biological problems will be emphasized.

Prerequisites: CHM 030 or CHM 040

Attribute/Distribution: NS

BIOS 238 Epigenetics, Health, and Environment 3 Credits

Foundational concepts in environmental epigenetics. Course will be centered around presentations and discussions of studies that address current issues, such as the mechanisms behind heritable health effects of acute malnourishment in human populations across multiple generations, or the potential for extremely fast evolutionary adaptation in species threatened by environmental change. This course may be listed as a Writing Intensive course.

Prerequisites: BIOS 044

Attribute/Distribution: NS

BIOS 239 Ecology and Evolution of Infectious Diseases 3 Credits

In this course, we will explore the causes and consequences of infectious disease at multiple scales—from whole organisms to entire ecosystems. By evaluating primary literature, leveraging theoretical models, and considering experimental design, we will aim to apply evolutionary and ecological understanding to the epidemics of the past, present, and future.

Prerequisites: BIOS 044 and BIOS 045

Attribute/Distribution: CC, NS

BIOS 251 Writing and Biological Sciences 3 Credits

A course designed to acquaint students with some of the intellectual foundations of science, with attention to the distinctiveness of the biological sciences. Format includes readings, intensive writing, extemporaneous speaking, and discussion. May not be used to fulfill Biology B.A. elective requirements.

Attribute/Distribution: NS, W

BIOS 261 Special Topics in Biological Sciences 1-3 Credits

Research, conferences and reports on selected topics not covered in the general undergraduate offerings. Consent of instructor required.

Repeat Status: Course may be repeated.

Attribute/Distribution: NS, W

BIOS 262 Research Proposal 3 Credits

Literature and methods of research in area of department faculty expertise. Requires development of detailed proposal for research to be performed in senior year. Must have major in any biological sciences degree program, junior standing, GPA of 3.0 in major, and consent of department.

Attribute/Distribution: NS, W, WRIT

BIOS 274 (HMS 274) Neuroethics 3 Credits

The intersection of neuroscience and ethics. History of biomedical science and current topics in neuroethics explored through weekly case studies and relevant readings in neurobiology. Examples include: definitions of mental illness, definitions of consciousness and brain death, addiction neuroscience, brain-machine interfaces, wearable technology, social determinants of health and equity within science and medicine. Reading and critical analysis of scientific articles, integration of biological concepts with moral reasoning, effective written communication and participation in peer review, oral presentations and group discussions.

Prerequisites: BIOS 044

Attribute/Distribution: NS, W

BIOS 276 Central Nervous System and Behavior 0,3 Credits

Neuronanatomy and neurophysiology of animal and human behavior. Feeding, thirst, sleep, emotions, learning, and psychopathology.

Prerequisites: BIOS 044

Attribute/Distribution: NS

BIOS 277 Experimental Neuroscience Laboratory 2 Credits

Structure and function of the mammalian brain with special attention to cellular morphology and organization. Widely used histological and behavioral techniques to determine how the shape and function of the nervous system regulates behavior. Experimental design, hypothesis testing, statistical analysis, reading and writing of scientific papers, basic histology and imaging.

Prerequisites: BIOS 276

Can be taken Concurrently: BIOS 276

Attribute/Distribution: NS, W

BIOS 278 Neurophysiology Laboratory 2 Credits

The functional electrical underpinnings of the nervous system explored through direct recordings and thorough data analyses. Experimental design, hypothesis testing, numerical analysis, reading and writing of primary science.

Prerequisites: BIOS 276

Can be taken Concurrently: BIOS 276

Attribute/Distribution: NS, Q

BIOS 279 Experimental Molecular Neuroscience Laboratory 2 Credits

Inquiry-based lab course emphasizing molecular and cellular neuroscience approaches to understanding the nervous system. Opportunity for making real research discoveries on the genetic and cellular underpinnings of brain function. Molecular genetic, bioinformatic, and neurochemical techniques. Can be taken more than once with instructor approval.

Repeat Status: Course may be repeated.

Prerequisites: BIOS 276

Can be taken Concurrently: BIOS 276

Attribute/Distribution: NS

BIOS 280 Neurogenetics and Behavior Laboratory 2 Credits

Inquiry-based lab course utilizing functional genetic and behavioral approaches to understand nervous system function. This course will provide students with opportunities to employ genome engineering techniques and behavioral analysis to make real research discoveries about the genetic underpinnings of behavior. This course is an approved lab for the Neuroscience major.

Prerequisites: BIOS 115 and BIOS 116

BIOS 300 Apprentice Teaching 1-4 Credits

Repeat Status: Course may be repeated.

BIOS 315 Neuropharmacology 3 Credits

Mechanisms of drug action in the central nervous system. Pharmacokinetics/pharmacodynamics. Depressant, stimulant, analgesics, and psychedelics. Treatments for neuropsychiatric disorders. Drug abuse.

Prerequisites: BIOS 276

Attribute/Distribution: NS

BIOS 317 Evolution 0,3 Credits

Mechanisms of evolution, emphasizing genetic structure and variation of populations, and isolation. Origin of species and higher taxa. Rates of evolution, extinction.

Prerequisites: BIOS 115

Attribute/Distribution: CC, NS

BIOS 318 Advanced Phage Research Laboratory 1-3 Credits

Apprentice-based laboratory research in phage biology in collaboration with faculty who direct Lehigh's SEA Phages Program (sponsored by the Howard Hughes Medical Institute). Research will focus on discoveries uncovered in SEA Phage courses and may include genetic, molecular, and biochemical analyses of novel bacteriophage genes, genomes, and novel gene functions. Additional research may include phage genome annotation using computational biology tools.

Repeat Status: Course may be repeated.

Prerequisites: BIOS 115 and BIOS 118

Attribute/Distribution: NS

BIOS 320 (ENTP 320) The Business of Life Science 3 Credits

An examination of business process in startup, early stage and developing bioscience companies. Technology assessment, business plan and proposal preparation, financial strategies, resource management, intellectual property, and legal as well as regulatory issues. Cannot be used to fulfill major or minor requirements in Biological Sciences.

Prerequisites: BIOS 121

Attribute/Distribution: NS

BIOS 323 Evolution of Development 3 Credits

This course examines how changes in the blueprint that describes the development of a multicellular animal from a single fertilized egg lead to the evolution of new species or new forms within a species.

Prerequisites: BIOS 317 or BIOS 376 or BIOS 327

Can be taken Concurrently: BIOS 317, BIOS 376, BIOS 327

BIOS 324 Microbiology 3 Credits

An examination of microbial life, including archaea, bacteria, fungi, protists and viruses. Emphasis on microbial molecular genetics and its relationship to the origin of life, human health/medicine, and the environment.

Prerequisites: BIOS 115

Attribute/Distribution: NS

BIOS 325 Microbiology Laboratory 2 Credits

Laboratory studies of microorganisms, focusing on bacteria and fungi. Techniques for isolating, culturing, and identifying microorganisms. Experiments in microbial molecular genetics, phylogenetics, and evolution using traditional and modern techniques, as well as other topics covered in BIOS 324.

Prerequisites: BIOS 324

Can be taken Concurrently: BIOS 324

Attribute/Distribution: NS

BIOS 326 Coevolution 3 Credits

Discussion-based seminar course covering readings from the primary literature. Course will examine evolutionary consequences of species interactions, interactions between the sexes, and genetic interactions. Topics will include predator-prey interactions, host-parasite interactions, sexual conflict, genomic conflict, mutualism, and more. Consequences of coevolution for biodiversity and human health will also be examined.

Prerequisites: BIOS 317

Attribute/Distribution: NS

BIOS 327 Development and Disease 3 Credits

Development of organs from precursor cells; diseases that impact organ function. Focus on understanding how mutations or other causes influence organ development and function. Combination lecture and primary literature.

Prerequisites: BIOS 376

Attribute/Distribution: NS

BIOS 328 Immunology 3 Credits

Distinction of "self" and "nonself" through humoral and cellular mechanisms. Antigens; biochemical structures, cellular mechanisms, genetic control and processing, phylogenetic distribution, diseased states.

Prerequisites: BIOS 115

Attribute/Distribution: NS

BIOS 330 Molecular Evolution 3 Credits

This course will focus on evolution at the level of individual genes, proteins, and genomes, alternating between lecture and discussion of papers from the recent primary literature. Topics include pathways for adaptive evolution, directionality in evolution, epistasis, evolvability, genome rearrangements and speciation, gene duplication, and evolutionary dynamics. We will draw on examples of molecular evolution in nature, laboratory model systems, and human pathogens.

Prerequisites: BIOS 317 or BIOS 345

Can be taken Concurrently: BIOS 317, BIOS 345

Attribute/Distribution: NS

BIOS 332 Behavioral Neuroanatomy 3 Credits

The study of neuroanatomy that underlies social and motivated behaviors and the techniques that support this study. Students learn by researching and reporting on original research, and ultimately designing and describing an original study on the topic.

Prerequisites: BIOS 276

Attribute/Distribution: NS, W

BIOS 334 Species and Speciation 3 Credits

Consideration of the origin of species. Discussion of a variety of "species" definitions and exploration of the evolutionary mechanisms by which new species arise. Alternation between lecture and discussion, drawing on the textbook and on current and classical literature.

Prerequisites: BIOS 317

BIOS 335 (PSYC 335) Animal Behavior 3 Credits

Discussion of the behavior of invertebrates and vertebrates and analysis of the physiological mechanisms responsible for behavioral stimuli, and adaptive value of specific behavior patterns.

Prerequisites: BIOS 044

Attribute/Distribution: NS

BIOS 336 Animal Behavior Laboratory 2 Credits

Experiments and field observations illustrating principles discussed in BIOS 335. Emphasis on observing animals, performing experiments, collecting and analyzing data, and individual research. Six hours of laboratory per week.

Prerequisites: BIOS 335 or BIOS 337

Can be taken Concurrently: BIOS 335, BIOS 337

Attribute/Distribution: NS

BIOS 337 Behavioral Ecology 3 Credits

Social systems of vertebrate and invertebrate groups. Emphasis on ecological and evolutionary factors that influence social behavior.

Prerequisites: BIOS 044

Attribute/Distribution: NS

BIOS 338 Neurodegenerative Diseases in Model Organisms 3 Credits

Discussion-based seminar course on the use of model systems to investigate neurodegenerative diseases. The primary focus will be on invertebrate model systems, including *Drosophila*. Critical reading of primary scientific literature and student discussion is required.

Prerequisites: BIOS 115

Attribute/Distribution: W

BIOS 339 Computational, Molecular Modeling and Simulation 3 Credits

This course is designed to introduce the most basic and key concepts, methods, and tools used in molecular modeling and simulation. This class is a hybrid of lecture and hands-on practice styles, using the lectures and tools in CHARMM-GUI (<http://www.charmm-gui.org/> lecture). Some topics include the UNIX operating system, text editors, Python programming and Monte Carlo simulation. The understanding of these concepts and algorithms, as well as their applications to well-defined practical examples involving currently important biological problems will be emphasized.

Attribute/Distribution: NS

BIOS 340 Molecular Basis of Disease 3 Credits

Lectures and student projects on molecular mechanisms of human disease. Physiology of disease, molecular mechanisms, therapeutic approaches, ongoing research. Topics include: neurodegenerative diseases, cancer, autoimmune diseases, infectious diseases.

Prerequisites: BIOS 115

Attribute/Distribution: NS

BIOS 341 Living Together: The Science of Host-Microbe Interactions 3 Credits

This course explores the fascinating and complex world of host-microbe interactions, examining the impact of host-associated microbes on biodiversity, ecology, and evolution. Using primary literature, we investigate the diversity of these interactions and the mechanisms driving them, and engage in lively group discussions and collaborative mini-reviews that hone scientific communication skills. By the end of the course, you will have gained a deep understanding of the latest research on host-microbe interactions and the tools to evaluate and communicate scientific ideas.

Prerequisites: BIOS 044 or BIOS 121 and BIOS 115

BIOS 342 Cellular Basis of Human Disease 3 Credits

Cell and molecular biological advanced topics relevant to human disease and/or health. Critical reading of the primary literature, discussion and student discussion required.

Prerequisites: BIOS 367 or BIOS 411

Attribute/Distribution: NS

BIOS 343 Personal Genomics 3 Credits

Contemporary methods and technologies for investigating human genetic variation and its use for inferring ancestry and risk for disease, along with discussions of relevant policy and ethics. Readings will include primary scientific literature in population and statistical genetics, government publications, and news reports. Final projects will involve development of outreach and education resources in this topic for non-experts.

Prerequisites: (BIOS 115 and BIOS 130) or BIOS 317

Attribute/Distribution: CC, NS

BIOS 345 Molecular Genetics 3 Credits

The organization and replication of genetic material; mutagenesis; mechanisms of regulation; mechanisms of gene transmission involving prokaryotes and eukaryotes and their viruses; techniques for intervention into genetic organization and expression.

Prerequisites: BIOS 115

Attribute/Distribution: NS

BIOS 346 Molecular Genetics Laboratory 2 Credits

Laboratory experiments related to the topics covered in BIOS 345. Emphasis is on molecular characterization of DNA and the principles of gene isolation and transfer.

Prerequisites: BIOS 345

Can be taken Concurrently: BIOS 345

Attribute/Distribution: NS

BIOS 347 Advanced Topics in Genetics 3 Credits

Lectures and student projects on selected aspects of genetics such as the genetics and evolution of particular organisms, regulation of gene expression and transmission, human genetics, gene therapy, etc. Consent of department chair.

Prerequisites: BIOS 115 and BIOS 116

Attribute/Distribution: NS

BIOS 348 Marine Biology 3 Credits

Ecology and adaptations of marine species, populations and ecosystems. Studying life in the ocean requires a perspective that spans spatial and temporal scales from the planetary to the microscopic, from the geologic to the physiological, and from the surface to the deepest seafloor. Through this course, students develop a fundamental understanding of how the physical environment of planet earth shapes and is shaped by marine organisms.

Prerequisites: BIOS 041 and BIOS 042

Attribute/Distribution: CC, NS

BIOS 349 Molecular Ecology 3 Credits

Molecular ecology is a field of research that seeks to answer questions in ecology, evolution, behavior and conservation; through the use of molecular tools. Biological scales range from organisms, to populations and species. This is a discussion-based course. Students read, present and analyze classic and modern scientific literature. Students also formulate a research proposal addressing outstanding questions in the field.

Prerequisites: BIOS 044

Attribute/Distribution: NS

BIOS 353 Virology 3 Credits

An introduction to viruses and their interactions with host organisms. Topics include viral pathogenesis, from entry through release, viral immune evasion mechanisms, and viral evolution. Vaccines, antiviral strategies, as well as therapeutic uses of viruses for gene therapy will be emphasized.

Prerequisites: BIOS 115

Attribute/Distribution: CC, NS

BIOS 365 Neurobiology of Sensory Systems 3 Credits

The fundamental features of sensory systems in a diverse array of animals. Focus on how nervous systems detect, compute, and internally represent aspects of the environment from the single cell to whole system level. Special attention to the way sensory processing influences how we think about the biological basis of perception and possible mechanisms for consciousness. Instructor permission required.

Prerequisites: BIOS 276

Attribute/Distribution: NS

BIOS 366 Diseases of the Nervous System 3 Credits

Neurobiological basis of CNS disorders, including affective, neurological and psychotic conditions. Emphasis on primary literature covering causes, diagnostic and treatment issues.

Prerequisites: BIOS 276 or BIOS 382

Attribute/Distribution: NS

BIOS 367 Cell Biology 3 Credits

Molecular aspects of cell biology. Emphasis on membrane structure and function, organelle biogenesis, cell motility, the cytoskeleton, and extracellular matrix.

Prerequisites: BIOS 115

Attribute/Distribution: NS

BIOS 368 Cell Biology Laboratory 2 Credits

Basic methods used in cell biology laboratories around the world and the opportunity to carry out an independent research project. Techniques include histology and microscopy (both white and fluorescent light), tissue culture and sterile procedures, cellular fractionation, nuclear import assays, and immunological probing. Consent of department required.

Prerequisites: BIOS 367

Can be taken Concurrently: BIOS 367

Attribute/Distribution: NS

BIOS 371 (CHM 371) Elements of Biochemistry I 0,3 Credits

A general study of carbohydrates, proteins, lipids, nucleic acids and other biological substances and their importance in life processes. Protein and enzyme chemistry are emphasized. Must have completed one year of organic chemistry.

Prerequisites: CHM 112

Attribute/Distribution: NS

BIOS 372 (CHM 372) Elements of Biochemistry II 3 Credits

Dynamic aspects of biochemistry; enzyme reactions including energetics, kinetics and mechanisms; metabolism of carbohydrates, lipids, proteins and nucleic acids; photosynthesis, electron transport mechanisms, coupled reactions, phosphorylations, and the synthesis of biological macromolecules.

Prerequisites: BIOS 473 or ((BIOS 371 or CHM 371) and BIOS 041)

Attribute/Distribution: NS

BIOS 375 Methods in Developmental Biology Lab 2 Credits

Detection of gene expression and protein expression in vivo or in vitro. Mutants and/or transgenics examined. Students address research questions of instructor.

Prerequisites: BIOS 376

Attribute/Distribution: NS

BIOS 376 Developmental Biology 3 Credits

Differentiation of multicellular organisms from a single cell. Axis determination; gradients; induction and pattern formation viewed through modern analysis of regulated gene expression. Lecture topics on organ formation paired with discussions on birth defects and human diseases.

Prerequisites: BIOS 115 and BIOS 116

Attribute/Distribution: NS

BIOS 377 (CHM 377) Biochemistry Laboratory 0,3 Credits

Laboratory studies of the properties of chemicals of biological origin and the influence of chemical and physical factors on these properties. Laboratory techniques used for the isolation and identification of biochemicals.

Prerequisites: (BIOS 371 or CHM 371) and (BIOS 041)

Can be taken Concurrently: BIOS 371, CHM 371

Attribute/Distribution: ND

BIOS 381 Physical Biochemistry 3 Credits

Topics include: thermodynamics of biological systems; Forces acting on and between biological molecules; Principles of macromolecular structure; Physical methods used to characterize biomolecules; and other topics to be determined.

Prerequisites: (BIOS 371 or CHM 371) and (BIOS 041)

Attribute/Distribution: NS

BIOS 382 (PSYC 382) Endocrinology 3 Credits

Organization and function of endocrine and neuroendocrine systems in regulating physiology and behavior. Emphasis on mammalian systems. Focus on critical thinking and problem-solving with reference to basic literature.

Prerequisites: BIOS 044

Attribute/Distribution: NS

BIOS 383 Biological Sciences Colloquia 0,1 Credits

Analysis of weekly colloquia in the biological sciences.

Repeat Status: Course may be repeated.

Prerequisites: BIOS 044

Attribute/Distribution: NS

BIOS 384 Eukaryotic Signal Transduction 3 Credits

Signal transduction between cells of multicellular eukaryotic organisms examined in the context of specialized functions that include: nutrition, hormones and neurotransmitters, vision, muscle contraction, adhesion, and the immune system. The evolution of cancer based on mutations in these signaling systems.

Prerequisites: BIOS 367 or BIOS 372 or CHM 372 or BIOS 382 or BIOS 365

Attribute/Distribution: W

BIOS 385 Synapses, Plasticity and Learning 3 Credits

Communication between neurons. Physiology of synaptic transmission; varying forms of neuronal plasticity; acquisition, encoding, and retrieval of memory.

Prerequisites: BIOS 276

Attribute/Distribution: NS

BIOS 386 Genes and the Brain 3 Credits

Modern molecular genetics techniques applied to complex brain processes. Emphasis on DNA and RNA manipulation strategies to elucidate mechanisms of complex behaviors. Animal models of learning, behavioral plasticity, and neuropsychiatric diseases.

Prerequisites: BIOS 276

Attribute/Distribution: NS

BIOS 387 Biological Sciences Honors Seminar 1 Credit

Development, presentation and implementation of research proposals, and discussions of research. Required for senior biology, molecular biology, biochemistry, and behavioral neuroscience majors pursuing departmental honors. Departmental permission required.

Attribute/Distribution: ND

BIOS 388 Biological Sciences Honors Seminar 1 Credit

Continuation and extension of BIOS 387. Departmental permission required.

Attribute/Distribution: ND

BIOS 389 Honors Project 1-6 Credits

Repeat Status: Course may be repeated.

BIOS 391 Undergraduate Research 1-3 Credits

Laboratory research under tutorial with a faculty member. Must have junior standing. Consent of instructor required.

Repeat Status: Course may be repeated.

Attribute/Distribution: ND

BIOS 393 Thesis 3 Credits

Literature review and design of project in selected area, execution of the project, final report and presentation. Consent of department required. Intended for senior majors in BIOS only. Consent of instructor required.

Repeat Status: Course may be repeated.

Attribute/Distribution: W

BIOS 401 Professional Skills for Biological Sciences Graduate Students 3 Credits

Students learn expectations and fundamental skills related to success in the biological sciences. The course is designed to help students make the most out of their graduate education. Students learn the principles underlying fundable, publishable research, and how these general principles can be applied to their specific research area. They learn to write and review manuscripts and grant proposals by serving on a mock editorial board and scientific review panel. They gain experience in giving oral presentations. Readings are from texts on scientific writing and research styles, and from original journal articles and grant proposals written by the faculty. Required of all Integrative Biology graduate students.

BIOS 402 Ethics and Rigor in Research 1 Credit

This course covers material critical to the responsible conduct of science, in addition to data reproducibility, rigor, research ethics, and misconduct.

BIOS 404 (PSYC 404) Behavioral Neuroscience 3 Credits

Theoretical and empirical issues in biopsychology. Must have graduate standing.

BIOS 405 Special Topics in Molecular Biology 1-3 Credits

Research, conferences, and reports on selected topics not covered in the general graduate offerings.

Repeat Status: Course may be repeated.

BIOS 406 Biological Sciences Seminar 0,1 Credits

An advanced seminar in current developments including departmental research. Required for candidates for graduate degrees in molecular biology.

Repeat Status: Course may be repeated.

BIOS 407 Research in Biological Science 1-9 Credits

Laboratory investigations in one of the department's research areas.

BIOS 408 Responsible Conduct of Science 0 Credits

Responsible practice in research. Training in general laboratory methods; human subjects concerns; radiation safety; chemical hazards; aseptic technique; physical, mechanical, biological, and fire hazards; animal welfare. Occupational and workplace considerations. Recombinant DNA guidelines; patent and proprietary rights; controversies over applications of science. Appropriate aspects required of investigators in all departmental research projects.

BIOS 410 Special Topics in Behavioral and Evolutionary Bioscience 1-3 Credits

Readings and discussions on selected topics not covered in the general graduate offerings.

BIOS 411 Advanced Cell Biology 3 Credits

Cell structure and biochemistry, as related to specialized cell functions.

BIOS 415 Synapses, Plasticity and Learning 3 Credits

Communication between neurons. Physiology of synaptic transmission; varying forms of neuronal plasticity; acquisition, encoding and retrieval of memory.

BIOS 421 Molecular Cell Biology I 3 Credits

Molecular aspects of cell structure, cell motility, intracellular transport; and biomembrane dynamics.

Prerequisites: BIOS 411

BIOS 422 Molecular Cell Biology II 3 Credits

Molecular aspects of gene expression, including genome structure and replication, RNA synthesis/processing, and protein synthesis.

Prerequisites: BIOS 345 or BIOS 345

BIOS 423 Evolution of Development 3 Credits

This course examines how changes in the blueprint that describes the development of a multicellular animal from a single fertilized egg lead to the evolution of new species or new forms within a species.

Prerequisites: BIOS 317 or BIOS 376 or BIOS 327

Can be taken Concurrently: BIOS 317, BIOS 376, BIOS 327

BIOS 424 Advanced Neurobiology of Sensory Systems 3 Credits

This course is designed to provide an overview of core principles of neuroscience through exploration of sensory systems. The course will provide an intensive review of fundamental neural signaling followed by a broad introduction to the major sensory pathways. Focus will be on major organizing principles of neural systems, and information processing. Student discussions and presentations will incorporate current literature and concepts.

BIOS 426 Coevolution 3 Credits

Discussion-based seminar course covering readings from the primary literature. Course will examine evolutionary consequences of species interactions, interactions between the sexes, and genetic interactions. Topics will include predator-prey interactions, host-parasite interactions, sexual conflict, genomic conflict, mutualism, and more. Consequences of coevolution for biodiversity and human health will also be examined.

BIOS 427 Techniques in Cell and Molecular Biology 1-3 Credits

Laboratory experiences in three or more cell and molecular biological techniques: gel electrophoresis of nucleic acids/proteins; polymerase chain reaction; DNA/RNA sequencing; molecular hybridization techniques; fluorescence microscopy; confocal microscopy; flow cytometry; electron microscopy tissue preparation; immunological detection methods; molecular cloning techniques; oocyte microinjection techniques; tissue culture methods; and autoradiography.

BIOS 428 Molecular Evolution 3 Credits

Evolution at the level of individual genes, proteins, and genomes. Lectures and discussion of papers from the recent primary literature. Topics include pathways for adaptive evolution, directionality in evolution, epistasis, evolvability, genome rearrangements and speciation, gene duplication, and evolutionary dynamics. Examples of molecular evolution in nature, laboratory model systems, and human pathogens.

Prerequisites: BIOS 317 or BIOS 345

Can be taken Concurrently: BIOS 317, BIOS 345

BIOS 431 Advanced Topics in Cell Biology 3 Credits

Current research problems in cell biology.

Repeat Status: Course may be repeated.

Prerequisites: BIOS 367 or BIOS 367 or BIOS 411

BIOS 432 Advanced Topics in Molecular Genetics 3 Credits

Current research in molecular genetics.

Repeat Status: Course may be repeated.

BIOS 433 Advanced Topics in Developmental Biology 3 Credits

Current research problems in developmental biology.

Repeat Status: Course may be repeated.

Prerequisites: BIOS 345 or BIOS 345

BIOS 434 Speciation 3 Credits

Discussion-based seminar course covering readings from classical and current literature, including both theoretical and empirical contributions. Topics will be included species concepts, reproductive isolation, mechanisms and modes of speciation, and current approaches to studying speciation.

BIOS 435 Epigenetics 3 Credits

Foundational concepts in environmental epigenetics. Course will be centered around presentations and discussions of studies that address current issues, such as the mechanisms behind heritable health effects of acute malnourishment in human populations across multiple generations, or the potential for extremely fast evolutionary adaptation in species threatened by environmental change.

BIOS 438 Neurodegenerative Diseases in Model Organisms 3 Credits

Discussion-based seminar course on the use of model systems to investigate neurodegenerative diseases. The primary focus will be on invertebrate model systems, including *Drosophila*. Critical reading of primary scientific literature and student discussion is required.

Prerequisites: BIOS 115

BIOS 439 Advanced Behavioral Ecology 3 Credits

Critical evaluation of the theoretical foundation in sociobiology.

Emphasis placed on kinship, altruism, mate choice, parental investment, parent-offspring conflict, etc. Lectures and seminars. Not open to students who have taken BIOS 337.

Prerequisites: BIOS 317 or BIOS 317

BIOS 441 Living Together: The Science of Host-Microbe Interactions 3 Credits

This course explores the fascinating and complex world of host-microbe interactions, examining the impact of host-associated microbes on biodiversity, ecology, and evolution. Using primary literature, we investigate the diversity of these interactions and the mechanisms driving them, and engage in lively group discussions and collaborative mini-reviews that hone scientific communication skills. By the end of the course, you will have gained a deep understanding of the latest research on host-microbe interactions and the tools to evaluate and communicate scientific ideas.

BIOS 442 Cellular Basis of Human Disease 3 Credits

Cell and molecular biological advanced topics relevant to human disease and/or health. Critical reading of the primary literature, discussion and student discussion required.

Prerequisites: BIOS 367 or BIOS 411

BIOS 443 Personal Genomics 3 Credits

Contemporary methods and technologies for investigating human genetic variation and its use for inferring ancestry and risk for disease, along with discussions of relevant policy and ethics. Readings will include primary scientific literature in population and statistical genetics, government publications, and news reports. Final projects will involve development of outreach and education resources in this topic for non-experts.

BIOS 448 Marine Biology 3 Credits

Ecology and adaptations of marine species, populations, and ecosystems. With an average depth of more than two miles, the ocean makes up more than 95% of the habitable space on our planet. Ocean ecosystems are essential life support systems for the entire earth. Studying life in the ocean requires a perspective that spans spatial and temporal scales from the planetary to the microscopic, from the geologic to the physiological, and from the surface to the deepest seafloor. Through this course,.

BIOS 449 Molecular Ecology 3 Credits

Molecular ecology is a field of research that seeks to answer questions in ecology, evolution, behavior and conservation; through the use of molecular tools. Biological scales range from organisms, to populations and species. This is a discussion-based course. Students read, present and analyze classic and modern scientific literature. Students also formulate a research proposal addressing outstanding questions in the field.

BIOS 450 Developmental Neurobiology 3 Credits

Fundamental mechanisms underlying neural development. Early events leading to the induction of the neuroectoderm and the reorganization of the vertebrate central nervous system during adulthood and aging. Major developmental events such as phenotype commitment, cell migration, differentiation and growth cone guidance. Emphasis on the interplay between concepts emerging from organismal and molecular levels of analyses.

BIOS 453 General Neuroanatomy 3 Credits

Graduate level study of the neuroanatomy and neurochemistry of systems that underlie behavior in vertebrates. Emphasis will be on the traditional and novel methodologies used to reveal neuroanatomical pathways as well as the function of these pathways. Consent of department required.

BIOS 457 Advanced Behavioral Neuroendocrinology 3 Credits

A seminar course that covers current primary literature on the hormone-nervous system interactions that underlie physiology and behavior. The course covers the neuroendocrinology of reproduction, sex behavior, parental behavior, social behavior, agonistic and territorial behavior, learning and memory, homeostasis (caloric, nutritional, water and salt balance, temperature regulation), circadian rhythms and seasonality in a variety of vertebrates.

BIOS 464 Molecular Biology of Eukaryotic Organisms 3 Credits

Comparative analysis of several eukaryotes as model systems in cell biology, developmental biology, genetics, and molecular biology.

BIOS 466 Structure and Function of RNAs and Ribonucleoprotein Complexes 3 Credits

Biochemistry and function of small nuclear RNPs, RNase P, ribosomes, self-splicing introns, signal recognition particle, RNA viruses. Functions of RNA in DNA replication, in regulation, as an enzyme, and as a repressor.

BIOS 471 Eukaryotic Signal Transduction 3 Credits

Signal transduction between and within cells of multicellular organisms examined in the context of specialized functions that include: nutrition, hormones and neurotransmitters, vision, muscle contraction, adhesion and the immune system. The evolution of cancer based on mutations in these signaling systems. Lecture, discussion, and student presentations.

Prerequisites: (BIOS 372 or CHM 372 or BIOS 411)

BIOS 472 (CHM 472) Lipids and Membranes 3 Credits

The study of lipids and lipid membranes similar to those found in mammalian cells including methods of synthesis, surface activity, bilayer and micellar structures, lipid mixing, fluidity, permeability and membrane stability. Special emphasis will be given to the current evidence for and against the lipid raft hypothesis.

Prerequisites: BIOS 372 or CHM 372

BIOS 473 (CHM 473) Principles of Biochemistry I 3 Credits

Study of proteins, carbohydrates, lipids, nucleic acids and other biological substances. Protein and enzyme chemistry are emphasized. Must have completed one year each of general chemistry and organic chemistry.

BIOS 474 Computational, Molecular Modeling and Simulation 3 Credits

This course is designed to introduce the basic and advanced concepts, methods, and tools used in molecular modeling and simulation. This class is a hybrid of lecture and hands-on practice styles, using the lectures and tools in CHARMM-GUI (<http://www.charmm-gui.org/lecture>). Topics include (but are not limited to) the UNIX operating system, text editors, Python programming, scientific programming using Python, PDB (Protein Data Bank) format, molecular mechanics, minimization, molecular dynamics, Monte Carlo simulation. The understanding of these concepts and algorithms, as well.

BIOS 477 (CHM 477) Topics in Biochemistry 1-3 Credits

Selected areas of biochemistry, such as mechanisms of enzyme action, new developments in the chemistry of lipids, nucleic acids, carbohydrates and proteins.

Repeat Status: Course may be repeated.

BIOS 483 Special Topics in Behavioral Neuroscience 3 Credits

Examination of the biological substrates of behavior. Topics may include animal communication, sociobiology, behavioral endocrinology, or behavior genetics.

Repeat Status: Course may be repeated.

BIOS 486 Genes and the Brain 3 Credits

Modern molecular genetics techniques applied to complex brain processes. Emphasis on DNA and RNA manipulation strategies to elucidate mechanisms of complex behaviors. Animal models of learning, behavioral plasticity, and neuropsychiatric diseases.

Attribute/Distribution: NS

BIOS 488 Seminar in Neuroscience, Behavior, and Evolution 1 Credit

Advanced seminar in current research developments.

BIOS 490 Thesis 1-6 Credits

Repeat Status: Course may be repeated.

BIOS 499 Dissertation 1-15 Credits