BIOLOGY (BIO)

BIO 5100 Seminars in Biology (1)
Graduate standing in biology and related fields. Topics of current interest in various subdisciplines of biology. Topics change each semester. Involves presentation of seminars by enrolled graduate students. May be repeated only with changes in topics.

BIO 5101 Graduate Scientific Communications (1)
Examination of various methods of scientific communication including leading undergraduate student groups in critical analysis and evaluation of scientific presentations and the current scientific literature.

BIO 5199 Non-Thesis Degree Completion (1)
To fulfill requirements for non-thesis master's students who need to complete final degree requirements other than coursework during their last semester. This may include such things as a comprehensive examination, oral examination, or foreign language requirement. Students are required to be registered during the semester they graduate.

BIO 5201 Research Methods in Biology (2)
Description and application of the major tools of professional biology, especially instruction on effective writing for obtaining graduate fellowships and research grants, and methods for presenting results of scientific research.

BIO 5202 Res Meth In Bio II (2)
Application of the major tools of professional biology, especially introductory programming, data management and visualization, and exploratory data analysis.

BIO 5203 Tropical and Emerging Infectious Diseases (2)
Provides a comprehensive overview of major neglected tropical diseases, HIV/AIDS, malaria, TB and emerging infections in the context of lecture-based learning and student-led evaluation of current literature emphasizing the rapidly changing global infectious disease climate.

BIO 5204 Applied Epidemiology, Biostatistics, and Public Health (2)
Reinforces the principles of public health as it applies to tropical medicine through epidemiologic investigations, statistical analyses, and evaluation of public health policy.

BIO 5205 Vector Biology and Vector Borne Diseases (2)
Pre-requisite(s): BIO 4102, 4302 Biology, entomology, and transmission dynamics of vector-borne diseases as they relate to the human and animal hosts.

BIO 5206 Biotechnology Operations (2)
Introduction to key principles and practices of a biotechnology operation, including lectures on management and project planning, product discovery, development and testing, clinical development, and the regulatory and quality management systems.

BIO 5207 Preclinical Models in Biotechnology (2)
Fundamentals of pre-clinical models used for vaccine development. The course emphasizes basic immunologic principles applied to vaccine development, natural and experimental animal models for efficacy testing, and design and execution of GXP animal studies. Additionally, fundamentals of US and international regulations governing human therapeutic development are covered.

BIO 5208 Bench to Bedside: Biopharmaceuticals, vaccine antigen production and transition to the clinic (2)
Pre-requisite(s): BIO 4307 or BIO 3342 or the consent of the instructor Fundamental principles of discovering and designing modern biopharmaceuticals including recombinant vaccine antigens. Discussion of issues facing the transition from bench to bedside.

BIO 5209 Topics in Advocacy and Policy for the Neglected Tropical and Emerging Infectious Diseases (2)
Introduction to key topics of advocacy and policy to communicate scientific or technical information effectively in a variety of public and professional interactions. Lectures include best practices for use of different communication methods and understanding the different types of public audiences.

BIO 5210 GIS and Health (2)
Provides a comprehensive overview of how dynamic geospatial and environmental factors influence human health and how GIS-based tools can be applied for analysis.

BIO 5211 Diagnostics of Neglected Tropical and Emerging Infectious Diseases (2)
Examination and evaluation of modern molecular and other point-of-care methods for detection of tropical and emerging infectious diseases.

BIO 5213 Research Methods in Biology III (2)
Investigation of the parameters necessary for effective experimental design and interpretation in the biological and biomedical research fields.

BIO 5300 Advanced Studies in Biology (3)
Special and advanced topics in biology. May be repeated once with change in content.

BIO 5302 Virology (3)
Cross-listed as BMS 5305 Pre-requisite(s): BIO 4106 and 4306 or equivalent
Material covered includes viral replication, molecular regulation, cellular life cycle, and pathogenesis; evolution, emerging diseases, and epidemiology; and prevention and control of viral diseases. Viruses which infect humans, domestic animals, and plants will be the focus. The global health perspective will be addressed throughout.

BIO 5303 Behavioral Ecology (3)
Pre-requisite(s): BIO 3403 or equivalent
Relationships among animal behavior, ecology, and evolution. Emphasis is on integrating current models with comparative and experimental evidence on how a particular behavior pattern contributes to an animal’s chances of survival and its reproductive success.

BIO 5304 Nucleic Acids (3)
This course examines recent developments in both DNA and RNA fields. Topics include nucleic acids structure, protein-nucleic acid interactions, techniques applied to nucleic acids, RNA decay, noncoding RNAs, RNA regulons, riboswitches, RNA bioinformatics and micro RNAs.
BIO 5305  Ecosystem Biogeochemistry (3)
This course provides the opportunity to synthesize the principles and current research in the discipline of Ecosystem Biogeochemistry through student-led teaching modules and a research synthesis project.

BIO 5306  Molecular Evolution (3)
Pre-requisite(s): BIO 2306 and 2106 Research in molecular genetics and its implications for evolutionary theory. Topics to be discussed include the evolutionary role of plasmids, temperate phage, transposons, introns, multigene families, organelle DNA, and DNA sequence divergence.

BIO 5307  Advanced Cell Biology (3)
Cross-listed as BMS 5307
Pre-requisite(s): BIO 4307 or 4308 or equivalents; or consent of instructor
Advanced topics in current cell biology research, including organelle and cytoskeleton structure and function, intra- and inter-cellular signaling, intracellular trafficking, cell cycle regulation, and cell division.

BIO 5310  Advanced Microbiology (3)
Pre-requisite(s): BIO 4401 or consent of instructor
Microorganisms, especially their mechanics of pathogenesis with emphasis on their distribution in nature, their beneficial and detrimental effects on humans, and the potential role of certain organisms in biowarfare.

BIO 5311  Advanced Genetic Analysis (3)
Pre-requisite(s): BIO 1105, 1106, 1305, 1306, 2306, 3342, and 4306 or equivalents; or consent of instructor
Principles and practice of classical and modern genetic analysis as applied to eukaryotic organisms, including yeast, nematodes, Drosophila, mice, and humans; isolation and analysis of mutations; gene mapping; suppressor analysis; chromosome structure; control of gene expression; and developmental genetics.

BIO 5315  Genomics & Infectious Diseases (3)
Pre-requisite(s): BIO 2306, 3342, 4308 or equivalents or consent of instructor
This course concerns new principles of genome science and explores their applications in infectious disease research. Topics include how pathogen and vector genomes are studied, how they function, and how they evolve. The importance of comparative and functional genomics along with use of arthropod disease vectors in identifying control mechanisms of human pathogens are highlighted.

BIO 5320  Ecological Biophysics (3)
Pre-requisite(s): BIO 3303 or BIO 3403; and MTH 1321, PHY 1408 and PHY 1409
First principle approaches that are used to describe microenvironments of living organisms and the energy and mass transfer between organisms and their external environment.

BIO 5325  Advanced Topics in Evolutionary Biology (3)
Pre-requisite(s): Consent of instructor
This course provides an opportunity to explore advanced evolutionary theory and its implementation. Emphasis on evolution as an integrative principle of biological science.

BIO 5330  Conservation Biology (3)
Cross-listed as ENV 5330
Pre-requisite(s): BIO 2306 and 3403 or equivalent
Biological forces influencing scarcity and diversity, emphasizing: genetics, fitness, population viability, extinction, endemism, habitat fragmentation, and community structure and stability.

BIO 5335  Climate Change and Biodiversity (3)
Pre-requisite(s): BIO 3303 and MTH 1320, or equivalents
Biological and conservation responses to naturally and human-induced climate change. Greenhouse gas levels, recent climate trends, range and abundance changes, phenological changes, evolutionary effects, climate change models and projections, designing landscapes and seascapes for change, managing the landscape matrix, and the future of biodiversity.

BIO 5340  Ecosystem Process Modeling (3)
Pre-requisite(s): MTH 1321 (or equivalent) and BIO 3403 (or equivalent)
Interactions among ecosystem elements are formalized in computer simulation. Identification of ecosystem sources/sinks, reservoirs, and flux pathways is presented with the biological interpretation of mathematical representation of ecological processes.

BIO 5345  Molecular Biology of Disease Vectors (3)
Pre-requisite(s): BIO2306 Genetics: BIO4308 Cell and Developmental Biology; or consent of instructor
This course provides an important foundation of knowledge of the biology of disease vectors, followed by current topics in vector biology, cell and developmental biology, physiology, gene drive system, old and new strategies in vector control and control of vector-borne diseases and vector/pathogen/host interactions.

BIO 5350  Biocomputing (3)
Pre-requisite(s): Consent of instructor
An introduction to the Python language and its specific application to genomic, proteomic, and environmental research. Emphasis on strings, data storage/access, and creating custom modules. Weekly coding projects will be based on each student's dissertation research. No coding experience is required.

BIO 5351  Advanced Biocomputing (3)
Pre-requisite(s): Consent of instructor
A Python-based course covering protein structure, phylogeny, DNA sequencing and transcriptome analysis, Markov chains, clustering, and machine learning. Weekly coding projects will be completed which are relevant, where possible, to each student's dissertation research. Strong skills in Python are required.

BIO 5355  Genomic Analysis (3)
Cross-listed as BMS 5355
Provides comprehensive instruction on the analysis of genomic data. An overview of basic genome biology, study design, NGS technology, and galaxy analysis tools is provided in addition to current best practices in the analysis of genomic data. Genomic Analysis focuses on analysis and detection of variants and transcriptomics from next-generation sequencing data including RNA-seq, ChIP-seq, and SNP-seq.

BIO 5360  Biological Invasions: Ecology and Management (3)
Cross-listed as ENV 5360
Pre-requisite(s): BIO 3403 or equivalent
The biology of invasive alien plants and animals, emphasizing evolutionary ecology, impacts on native species, and effects on biodiversity. Biological invasion causes, pathways, vectors, and management strategies in terrestrial and aquatic systems.

BIO 5377  Landscape Ecology (3)
Cross-listed as ENV 5377
Pre-requisite(s): BIO 3403, MTH 1304, or equivalent
Ecological factors influencing landscape structure and dynamics. Emphasis on landscape structure, exchanges among landscape components, and landscape stability and management.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Pre-requisites</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIO 5380</td>
<td>Integrative Ecophysiology</td>
<td>3</td>
<td>BIOS 4431 or instructor approval</td>
<td>Application of the basic principles of nutrition to the study of fish, reptiles, birds, and mammals in their natural environments.</td>
</tr>
<tr>
<td>BIO 5399</td>
<td>Experimental Design and Research Communications for Molecular Biologists</td>
<td>3</td>
<td>Consent of instructor</td>
<td>This course provides in-depth training on how to formulate research hypothesis and questions and how to present the specialized areas of student research to general and professional audiences.</td>
</tr>
<tr>
<td>BIO 5400</td>
<td>Population Genetics</td>
<td>4</td>
<td>BIOS 2306 or equivalent</td>
<td>Basic concepts and current research in population genetics. Topics covered include genetic variation in natural populations, evolutionary forces causing change in gene frequency, linkage disequilibrium, quantitative variation, and the genetics of speciation.</td>
</tr>
<tr>
<td>BIO 5401</td>
<td>Microbial Ecology</td>
<td>4</td>
<td>BIOS 2306 or equivalent</td>
<td>Interactions and transformations of microorganisms in soil, air, and water. Emphasis on methodology and practical relationships of microorganisms in the environment.</td>
</tr>
<tr>
<td>BIO 5402</td>
<td>Invertebrate Zoology</td>
<td>4</td>
<td>BIOS 3403 or equivalent</td>
<td>Diversity and phylogenetic development of all non-vertebrate phyla. Current areas of research in invertebrate biology are examined.</td>
</tr>
<tr>
<td>BIO 5403</td>
<td>Population Ecology</td>
<td>4</td>
<td>BIOS 3403 or equivalent and BIOS 5412 or MTH 2381 or STA 3381 Lectures, discussions, and field studies that illustrate basic concepts and current research in theoretical and applied population ecology. Topics include life tables, census techniques, single-species population and metapopulation dynamics, population regulation, population dynamics in competitive and predator/prey interactions, and the conservation of populations. Includes an independent research project.</td>
<td></td>
</tr>
<tr>
<td>BIO 5404</td>
<td>Wetland Ecology and Management</td>
<td>4</td>
<td>ENV 5404</td>
<td>Cross-listed as ENV 5404. Prerequisite(s); BIOS 3403 or equivalent. Lecture, laboratory, and field studies of the ecology and management of North American wetland environments. Emphasis will be placed on the ecology of aquatic and wetland plants and their role in determining wetland structure and function. Overnight field trip required.</td>
</tr>
<tr>
<td>BIO 5405</td>
<td>Stream Ecology</td>
<td>4</td>
<td>ENV 5405</td>
<td>Cross-listed as ENV 5405. Physical, chemical and biological organization of streams. Topics include geomorphology and hydrology, water chemistry, ecosystem processes in streams, watershed-stream linkages, and bioassessment methods.</td>
</tr>
<tr>
<td>BIO 5407</td>
<td>Bioenergetics</td>
<td>4</td>
<td>BIOS 5405 or equivalent</td>
<td>Discussion and laboratory experiences on the processes, pathways, and rate of biological energy transformation.</td>
</tr>
<tr>
<td>BIO 5408</td>
<td>Plankton Ecology</td>
<td>4</td>
<td>BIOS 3303 or equivalent or consent of instructor</td>
<td>Plankton comprise the most important community of oceans and most lakes. Their metabolism drives the global carbon cycle and supports global fisheries. We consider all plankton, but focus on the middle of the food web, i.e., the zooplankton as an intermediary between the phytoplankton producers and the fish consumers. The course has a strong hands-on component with experimental laboratory experiences.</td>
</tr>
<tr>
<td>BIO 5409</td>
<td>Cancer Biology</td>
<td>4</td>
<td>BIOS 4306 or BIOS 4307 or BIOS 4308 or consent of the instructor</td>
<td>Basic concepts and current research in cancer biology. Topics include the cell intrinsic regulation of growth control, the accumulation of mutations, and the cell biological and micro-environmental changes associated with cancer, as well as therapeutic strategies. Current literature is discussed.</td>
</tr>
<tr>
<td>BIO 5412</td>
<td>Biometrics</td>
<td>4</td>
<td>MTH 1304 or equivalent</td>
<td>Principles and methods for experimental design, quantitative analysis, and interpretation of biological data, including application of mainframe computer packages.</td>
</tr>
<tr>
<td>BIO 5413</td>
<td>Advanced Ecological Data Analysis</td>
<td>4</td>
<td>ENV 5413</td>
<td>Cross-listed as ENV 5413. Pre-requisite(s); BIOS 5412 or equivalent. Current approaches to analyzing and interpreting complex biological data. Emphasis on integrative analysis strategies using modern statistical modeling techniques. Hands-on analysis of data sets using the statistical package R.</td>
</tr>
<tr>
<td>BIO 5420</td>
<td>Transmission Electron Microscopy</td>
<td>4</td>
<td>Consent of instructor</td>
<td>Use and operation of the transmission electron microscope and ancillary equipment as instruments of biological research, with special emphasis on tissue preparation, sectioning, examination, data acquisition, and photography.</td>
</tr>
<tr>
<td>BIO 5421</td>
<td>Scanning Electron Microscopy</td>
<td>4</td>
<td>Consent of instructor</td>
<td>Use and operation of the scanning electron microscope and support equipment. Specimen preparation, specimen examination, data acquisition, and data analysis are emphasized.</td>
</tr>
<tr>
<td>BIO 5425</td>
<td>Molecular Ecology</td>
<td>4</td>
<td>Consent of instructor</td>
<td>Basic concepts and current laboratory techniques in molecular ecology. Emphasis is on use of these skills in addressing basic and advanced ecological questions.</td>
</tr>
<tr>
<td>BIO 5V90</td>
<td>Special Problems</td>
<td>1-6</td>
<td>Consent of instructor</td>
<td>Advanced work in biology. Subject and hours of credit agreed upon by student and professor prior to registration. For master's and doctoral students.</td>
</tr>
<tr>
<td>BIO 5V99</td>
<td>Thesis</td>
<td>1-6</td>
<td>Consent of major professor</td>
<td>Research, data analysis, writing, and oral defense of an approved master's thesis. At least six hours of BIO 5V99 are required.</td>
</tr>
<tr>
<td>BIO 6101</td>
<td>Research Rotation</td>
<td>1</td>
<td>Consent of instructor</td>
<td>The research rotation allows students to become familiar with different areas of research, learn new experimental techniques, obtain experience in different research laboratories, and ultimately identify a lab in which to conduct dissertation research.</td>
</tr>
<tr>
<td>BIO 6V10</td>
<td>Doctoral Prospectus Research</td>
<td>1-2</td>
<td>Consent of Instructor</td>
<td>Supervised research for writing a dissertation research proposal and designing experimental approaches that will be the subject of a preliminary exam that will admit students to candidacy. A student may repeat this course for credit, with a maximum of 4 total hours.</td>
</tr>
</tbody>
</table>
BIO 6V99 Dissertation (1-12)
Pre-requisite(s): Consent of major professor
Research, data analysis, and writing and oral/written defense of an approved doctoral dissertation. At least twelve hours of BIO 6V99 are required.