

# BIO - Biology

---

## Biology: BIO

### Lower-Division Courses

#### **BIO 101C, 301C, 401C, 601C. Topics in Biology.**

Topics in biology that are especially relevant to current issues and problems in modern society. For each semester hour of credit earned, one lecture hour a week for one semester. Some topics require one additional discussion hour or three or four additional laboratory hours a week. May not be counted toward a degree in biology. May be repeated for credit when the topics vary. Prerequisite: Varies with the topic.

**Topic 1: The Biology of Being Human.** Introductory biology course that covers human evolution, genetics and genomics, behavior, population growth and environmental issues. May not be counted toward a degree in the College of Natural Sciences.

#### **BIO 301E. Problems in Modern Biology.**

An introduction to major concepts in biology, with emphasis on topics, such as genetics, that are relevant to current issues in the field. Three lecture hours and one discussion hour a week for one semester. Biology 301E and 301L may not both be counted; Biology 301E and 301M may not both be counted. May not be counted toward a degree in biology. Prerequisite: Admission to the Plan II Honors Program.

#### **BIO 102C, 202C, 302C, 402C. Conference Course.**

Supervised study of selected subjects in biology, by individual arrangement with the instructor. Conference course. May be repeated for credit. Prerequisite: Varies with instructor.

#### **BIO 302D (TCCN: BIOL 1309). Science Literacy and Numeracy: Ecology and Evolution.**

Explore science literacy and numeracy skills through methods of inquiry; dealing with quantitative data; and correcting common misconceptions regarding rational and quantitative thought. Examine these skills in the context of news events that include reference to some or all of the following: Mendelian genetics; microevolution; macroevolution; population ecology; community ecology; ecosystem ecology. Three lecture hours and one discussion hour a week for one semester.

#### **BIO 302E (TCCN: BIOL 1308). Science Literacy and Numeracy: Genetics and Genomics.**

Explore science literacy and numeracy skills through methods of inquiry, dealing with quantitative data and correcting common misconceptions regarding rational and quantitative thought. Examine these skills in the context of news events that include reference to some or all of the following: human genetics; analysis and manipulation of DNA; genetic testing; assisted reproductive technology; human ancestry; personalized medicine; forensic genetics. Three lecture hours and one discussion hour a week per semester

#### **BIO 302F. Science Literacy and Numeracy: Human Health and Disease.**

Explore science literacy and numeracy skills through methods of inquiry, dealing with quantitative data and correcting common misconceptions regarding rational and quantitative thought. Examine these skills in the context of news events that include reference to some or all of the following: metabolic diseases, infectious diseases, genetic diseases - causes, prevention, and treatments. Three lecture hours and one discussion hour a week for one semester.

#### **BIO 302G. Science Literacy and Numeracy: Biotechnology and the Future.**

Explore science literacy and numeracy skills through methods of inquiry, dealing with quantitative data and correcting common misconceptions regarding rational and quantitative thought. Examine these skills in the context of news events that include reference to some or all of the following: climate change; genetically modified organisms; biomedical technology. Three lecture hours and one discussion hour a week for one semester

#### **BIO 206L. Introductory Laboratory Experiments in Biology.**

The organizing principles of biology (such as molecular and cellular functions, reproduction, development, homeostatic mechanisms, and organismal physiology and behavior) are used within a comparative and evolutionary framework to train students in modern laboratory techniques, bioinformatics, experimental design, and interpretation of results. One lecture hour and four laboratory hours a week for one semester. Biology 106M and 206L may not both be counted. Prerequisite: Credit or registration for one of the following: Biology 311C, 311D, 315H, or 325H

#### **BIO 106M. Introduction to Lab Experiments in Biology.**

Explore the organizing principles of biology (such as, molecular and cellular functions, reproduction, development, homeostatic mechanisms, and organismal physiology and behavior) and how they are used within a comparative and evolutionary framework in modern laboratory techniques, bioinformatics, experimental design, and interpretation of results. One lecture hour and three laboratory hours a week for one semester. Biology 106M and 206L may not both be counted.

#### **BIO 106N. Introduction to Lab Experiments in Biology II.**

One lecture hour and three laboratory hours a week for one semester. Biology 206L and 106N may not both be counted.

#### **BIO 208L. Field Biology.**

Field projects, laboratory exercises, field trips, and computer simulation exercises to acquaint students with the principles and applications of ecology and some of the experimental and descriptive methods of ecological investigations. One lecture hour and four laboratory hours a week for one semester. Prerequisite: Credit or registration for Biology 311D.

#### **BIO 311C (TCCN: BIOL 1306). Introductory Biology I.**

Introduction to biological energy transformation, cell structure and physiology, and gene expression. Three lecture hours and one discussion hour a week for one semester. Only one of the following may be counted: Biology 301L, 211, 311C. Biology 311C and 212 may not both be counted. Prerequisite: Credit or registration for Chemistry 301, 301C, or 301H.

#### **BIO 311D (TCCN: BIOL 1307). Introductory Biology II.**

Introduction to mechanisms of inheritance, evolution, physiology, and species interactions. Three lecture hours and one discussion hour a week for one semester. Biology 301L and 311D may not both be counted. Biology 301M and 311D may not both be counted. Prerequisite: Biology 311C with a grade of at least C- and credit or registration for Biology 206L.

#### **BIO 315H. Advanced Introduction to Genetics: Honors.**

Basic principles of genetics and cell biology. Emphasis on gene structure and regulation; transmission of heritable traits; structure and function of cells; bacterial and viral genetics; and recombinant DNA technology. Three lecture hours and one discussion hour a week for one semester. Prerequisite: A score of 4 or 5 on the College Board Advanced Placement

Examination in Biology and credit or registration for Chemistry 301, 301C, or 301H.

### **BIO 119S, 219S, 319S, 419S, 519S, 619S, 719S, 819S, 919S. Topics in Biology.**

This course is used to record credit the student earns while enrolled at another institution in a program administered by the University's Study Abroad Office. Credit is recorded as assigned by the study abroad adviser in the Biology Instructional Office. University credit is awarded for work in an exchange program; it may be counted as coursework taken in residence. Transfer credit is awarded for work in an affiliated studies program. . May be repeated for credit when the topics vary.

## **Upper-Division Courses**

### **BIO 320. Cell Biology.**

Principles of eukaryotic cell structure and function; macromolecules, membranes, organelles, cytoskeleton, signaling, cell division, differentiation, motility, and experimental methodologies. Three lecture hours and one discussion hour a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 320L. Cell Biology Laboratory.**

Explores the complex structures and functions of cells through direct observation and experimentation. Subjects may include regulation of gene transcription and translation, protein sorting, organelles and membrane trafficking, cytoskeletal dynamics, and cell division. Use a combination of modern molecular biology, biochemistry, and microscopy techniques, with a strong emphasis placed on hypothesis-driven approaches, proper experimental design, and clear scientific writing and presentation. One lecture hour and five laboratory hours a week for one semester. Prerequisite: The following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Sciences 311.

### **BIO 321G. Principles of Computational Biology.**

Introduces computational methods for the analysis of nucleic acid and protein sequences, with applications towards biological problems. Performance assessment will be based on experiential learning methods. Three lecture hours and two computer laboratory hours a week for one semester. Prerequisite: The following with a grade of at least C-: Biology 325 or 325H; Statistics and Data Sciences 320E or 328M; and Mathematics 408C, 408S, or 408R.

### **BIO 321L. Aquatic Entomology.**

The taxonomy of aquatic insects; the use of aquatic insects in biomonitoring. Two lecture hours and three laboratory hours a week for one semester. Only one of the following may be counted: Biology 321L, 370C (Topic: Applied Aquatic Entomology), 384K (Topic 13). Prerequisite: The following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Science 311.

### **BIO 322. Structure, Physiology, and Reproduction of Seed Plants.**

The principles of structure and functioning of higher plants; special attention to the dynamics of growth and development and reproduction. Three lecture hours a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-; Chemistry 302, 302C, or 302H; and concurrent enrollment in Biology 122L.

### **BIO 122L. Structure, Physiology, and Reproduction of Seed Plants Laboratory.**

Observation of structure and reproduction in seed plants and employment of experimental techniques that demonstrate physiological processes, especially processes of growth and development. Two laboratory hours a week for one semester. Prerequisite: Concurrent

enrollment in Biology 322; and the following with a grade of at least C-: Biology 206L, 208L, 226L or Environmental Sciences 311.

### **BIO 324. Survey of the Plant Kingdom.**

Survey of the groups of living and fossil plants, comparing organization and reproduction to understand major shifts in the evolution of plant life. Three lecture hours a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-, and concurrent enrollment in Biology 124L.

### **BIO 124L. Survey of the Plant Kingdom Laboratory.**

Hands-on exploration of major plant groups emphasizing organization, reproduction and evolution. Cultures, prepared and living material examined. Local field trips. Designed to pair with Biology 324 lectures. Two laboratory hours a week for one semester. Prerequisite: Concurrent enrollment in Biology 324; and the following with a grade of at least C-: Biology 206L, 208L, 226L or Environmental Sciences 311.

### **BIO 325. Genetics.**

Basic principles of Mendelism, molecular genetics, structure and function of genes and chromosomes, populations and evolution. Three lecture hours and one discussion hour a week for one semester. Biology 325 and 325H may not both be counted. Prerequisite: Biology 311C and 311D with a grade of at least C- in each and credit or registration for Statistics and Data Sciences 320E, 321, or 302F.

### **BIO 325H. Genetics: Honors.**

Basic principles of genetics and evolution. Emphasis on population genetics and natural selection; structure and function of organ systems; behavioral ecology; and mutational analysis of organismal development. Three lecture hours and one discussion hour a week for one semester. Biology 325 and 325H may not both be counted. Prerequisite: Biology 315H with a grade of at least C-.

### **BIO 325L. Laboratory Experience in Genetics.**

Experimentation and direct observation in fundamental aspects of transmission genetics. One lecture hour and four laboratory hours a week for one semester. Prerequisite: The following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Sciences 311.

### **BIO 325T. Human Genetics.**

Genomics, cancer genetics, identification and analysis of human disease genes, and monogenic and multifactorial traits in humans. Three lecture hours a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 226L. General Microbiology Laboratory.**

Introduction to microbiology laboratory techniques and experimental demonstration of principles of microbiology. One lecture and three laboratory hours a week for one semester. Prerequisite: Credit with a grade of at least C- or registration for Biology 326M or 326R.

### **BIO 326M. Introductory Medical Microbiology and Immunology.**

Designed primarily for nursing and prepharmacy students. Overview of the structure, function, and genetics of bacteria, viruses, and fungi, with emphasis on the interactions between micro-organisms and the human host. Includes principles of microbial pathogenesis, the host's innate and adaptive immune responses to infection, epidemiology, laboratory diagnosis, and antimicrobial chemotherapy and vaccines. Three lecture hours and one discussion hour a week for one semester. Prerequisite: Biology 311C; Biology 325 or 325H with a grade of at least C-; Chemistry

301 with a grade of at least C-; and one of the following with a grade of at least C-: Mathematics 408C, 408K, 408N, 408R.

### **BIO 326R. General Microbiology.**

Overview of the major areas of microbiological study, including cell structure and function, genetics, host-microbe interactions, physiology, ecology, diversity, and virology. Three lecture hours and one discussion hour a week for one semester. Prerequisite: Credit with a grade of at least C- or registration for Biology 325 or 325H, and Chemistry 302, 302C, or 302H with a grade of at least C-.

### **BIO 327D. Emerging Infectious Diseases.**

Genomic and proteomic tools used to understand the causes of human infectious diseases. Covers genome sequencing, community sequencing, proteomics, microarrays, and human polymorphism analysis; and how these technologies have been applied to the study of important human viral diseases. Also includes extensive coverage of the molecular and clinical biology of these diseases. Three lecture hours a week for one semester. Biology 327D and 337 (Topic: Emerging Infectious Diseases) may not both be counted. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 327G. Genomics.**

Genome structure, organization, and function of model organisms; theory and methodology of genetic and physical mapping; sequencing analysis and annotation; genome duplication and evolution; and ethics for biotechnology and cloning. Three lecture hours a week for one semester. Biology 327G and 337 (Topic: Genomics) may not both be counted. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 328. Introductory Plant Physiology.**

General principles of the mineral nutrition, water relations, metabolic activities, growth and development of green plants. Three lecture hours a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-, and Chemistry 302, 302C, or 302H.

### **BIO 328D. Discovery Laboratory in Plant Biology.**

Learning methods of experimental design, data gathering, data interpretation, and data presentation, including original experiments relating to questions of current interest in plant physiology. Five laboratory hours a week for one semester. Biology 328D and 337 (Topic: Discovery Laboratory in Plant Biology) may not both be counted. Prerequisite: The following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Sciences 311.

### **BIO 128L. Laboratory Experiments in Plant Physiology.**

Introduction to experimental techniques used in the study of the mineral nutrition, water relations, metabolic activities, growth, and development of green plants. Three laboratory hours a week for one semester. Prerequisite: Credit with a grade of at least C- or registration for Biology 328; and the following with a grade of at least C-: Biology 206L, 208L, 226L, or Environmental Sciences 311.

### **BIO 129S, 229S, 329S, 429S, 529S, 629S, 729S, 829S, 929S. Topics in Biology.**

This course is used to record credit the student earns while enrolled at another institution in a program administered by the University's Study Abroad Office. Credit is recorded as assigned by the study abroad adviser in the Biology Instructional Office. University credit is awarded for work in an exchange program; it may be counted as coursework taken in residence. Transfer credit is awarded for work in an affiliated studies program. May be repeated for credit when the topics vary.

### **BIO 330. Molecular Biology of Animal Viruses.**

Mechanisms by which viruses replicate and kill or transform cells. Three lecture hours a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 230L. Virology Laboratory.**

Basic experimental techniques applied to selected bacteriophages and animal viruses. Four laboratory hours and one discussion hour a week for one semester. Prerequisite: Biology 226L with a grade of at least C-, and credit with a grade of at least C- or registration for Biology 330.

### **BIO 331L. Laboratory Studies in Molecular Biology.**

Explores molecular biology methods, experimental design, and analyses applicable to both research and fields such as healthcare, biotechnology, and genetic analyses. Conducts experiments in a research project format. One lecture hour and four and one-half laboratory hours a week for one semester. Prerequisite: The following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Sciences 311.

### **BIO 335. Introduction to Biochemical Engineering.**

Microorganisms in chemical and biochemical synthesis; genetic manipulation of cells by classical and recombinant DNA techniques. Enzyme technology; design of bioreactors and microbial fermentations; separations of biological products. Three lecture hours a week for one semester. Only one of the following may be counted: Biology 335, Biomedical Engineering 339, Chemical Engineering 339, 379 (Topic: Introduction to Biochemical Engineering). Prerequisite: Biochemistry 339F or 369, and Biology 311C with a grade of at least C-.

### **BIO 336. Tumor Biology.**

Covers core aspects of cancer pathology, treatment, epidemiology, the discovery of oncogenes and tumor suppressors, and the molecular genetics underlying the characteristic features of malignant tumors (including metastatic behavior, genomic instability, angiogenesis, cell cycle regulation, and apoptosis). Strong emphasis on the biochemical functions of cancer-related proteins and enzymes and therapeutic approaches based on our understanding of these proteins. Important experimental approaches that have influenced our current understanding of cancer will also be stressed. Three lecture hours a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-; and one of the following with a grade of at least C-: Biochemistry 339F, 369, Biology 330, 360K.

### **BIO 137, 237, 337, 437. Selected Topics in Biology.**

Recent developments and research methods in the biological sciences. For each semester hour of credit earned, one lecture hour a week for one semester. Some topics may require additional hours. May be repeated for credit when the topics vary. Prerequisite: Biology 325 or 325H with a grade of at least C-; additional prerequisites vary with the topic.

**Topic 1: Seminar in Human Biology.** One lecture hour a week for one semester. Only offered as Biology 137. Prerequisite: Biology 346 with a grade of at least C-.

**Topic 2: Research Methods: UTeach.** Restricted to students in the UTeach-Natural Sciences program. Students perform independent inquiries and use skills from mathematics and science to solve research problems.

**Topic 3: Natural History of Protists.** A study of protista, a wide variety of eukaryotic organisms which are either unicellular or phylogenetically closely allied to unicellular organisms. Description of the basic taxonomic and ecological groups, and description of the natural history of the major groups of organisms.

**Topic 4: Computational Neuroscience and Neural Networks.**

**Topic 5: Grant Writing and Research Skills.** Explores skills required of research scientists, and specifically prepares students to submit a NSF Graduate Research Fellowship Proposal (NSF-GRFP) grant proposal during the semester (deadline for GRFP submission is typically during the last week of October). There are weekly writing milestones to complete an NSF-GRFP proposal by the submission deadline. Additional prerequisite: Upper-division standing and Statistics and Data Sciences 320E or 328M with a grade of at least C-.

**Topic 6: Practical Ethics for Biologists.** Incorporates weekly case studies to introduce common ethical issues faced by biologists in the field and the lab. Employs the Systematic Moral Analysis framework to critically examine ethical issues in scientific inquiry in general (data integrity, who pays for science) as well as issues specific to biologists in the field and laboratory (questionable research practices, conflicts of interest, expertise vs advocacy). Explores issues of personal values, implicit bias and environmental justice.

**Topic 9: The Emergence of Modern Biology.** Explore biology through an analysis of classic texts from the age of Darwin to the present day. Survey the theory of evolution by natural selection, genetics and the Modern Synthesis, population and community ecology, molecular biology and genomics.

**Topic 10: Renewable Resources: Environment and Future.** Greenhouse gases and their effect on climate and the oceans, renewable energy and materials such as biofuels, bioplastics, and green chemistry: minimizing the generation of chemical waste in manufacturing processes. Biology 337 (Topic: Renewable Rsrcs: Envir/Future) and 137, 237, 337, and 437 (Topic 10) may not both be counted.

**Topic 13: Advanced Genetics.** Examine basic principles of Mendelian and molecular genetics, and explore the genetic toolbox using examples of analytic methods and modern manipulations. Focus on the genetic analysis of model organisms and human diseases. Use genetic tools in the dissection of complex biological pathways, developmental processes, and regulatory systems. Produce an independent research proposal and presentation focusing on a current question in molecular genetics. Additional prerequisite: Consent of instructor.

### **BIO 337J. Computational Biology Laboratory.**

Overview of computational biology, with emphasis on nucleic acid sequence analysis and databases. Class projects and self-learning exercises. Two lecture hours and three computer laboratory hours a week for one semester. Prerequisite: Biology 325 or 325H, and Statistics and Data Sciences 328M with a grade of at least C- in each.

### **BIO 438L. Animal Communication.**

Animal communication from a multidisciplinary perspective, with emphasis on quantitative analysis, sensory processing, and evolution of signals. Three lecture hours and three laboratory hours a week for one semester, with computer laboratory hours as required. Prerequisite: Biology 325 or 325H with a grade of at least C-, and Biology 359K or 370 with a grade of at least C-.

### **BIO 339M. Bacterial Behavior and Signaling Mechanisms.**

Examine molecular, cellular, organismal, ecological, and evolutionary biology of bacteria. Focus on a large number of bacteria, both Gram-positive and Gram-negative from four major phyla, that live and survive both as free-living microbes, in groups, and in both beneficial and pathogenic associations with eukaryotic hosts. Explore evolution of organelles and behaviors, including receiving and transducing signals that produce a variety of outcomes such as chemotaxis and motility, morphogenesis and development, secretion and virulence, quorum sensing and biofilms, bacterial warfare, and antibiotic production and tolerance. Three lecture hours a week for one semester. Prerequisite:

Biology 325 or 325H with a grade of at least C-, and Biology 326R with a grade of at least C-.

### **BIO 340L. Biology of Birds.**

Anatomy, physiology, classification, and ecology of birds. Two lecture hours and three laboratory hours a week for one semester. Prerequisite: The following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Sciences 311.

### **BIO 344. Molecular Biology.**

Molecular basis of cellular processes: gene structure and function, DNA replication, RNA and protein synthesis, viruses, molecular aspects of immunology and cancer, and recombinant DNA. Three lecture hours and one discussion hour a week for one semester. Prerequisite: Biology 325 or 325H, and Biochemistry 369 or 339F with a grade of at least a C-.

### **BIO 345E. Endocrinology.**

Vertebrate endocrinology (primarily mammalian), with a focus on human pathophysiology. Three lecture hours and one discussion hour a week for one semester. Biology 337 (Topic: Endocrinology) and 345E may not both be counted. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 346. Human Biology.**

Introduction to human evolution, genetics, sexuality, senescence, and population growth. Three lecture hours and one discussion hour a week for one semester. Only one of the following may be counted: Biology 301G, 309F, 346. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 446L. Human Microscopic and Gross Anatomy.**

Designed for students preparing for biomedical research and the health professions. Focuses on microscopic and gross anatomy of human tissues and organs, with an emphasis on structure function relationships. Subjects include the effects of disease and aging in addition to normal human anatomy. Three lecture hours and four laboratory hours a week for one semester. Prerequisite: The following courses with a grade of at least C-: Biology 325 or 325H; Chemistry 301; and Mathematics 408C, 408K, 408N, or 408R.

### **BIO 448L. Invertebrate Biology.**

A study of the diversity and evolution of multicellular invertebrate animals, with emphasis on common themes in animal body construction and function. Three lecture hours and three laboratory hours a week for one semester. Prerequisite: The following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Science 311.

### **BIO 349L. Experiments in Developmental Biology.**

An investigation of methods and principles of developmental biology in a laboratory context, with emphasis on animal embryology using molecular techniques and microscopy. One lecture hour and six laboratory hours a week for one semester. Prerequisite: The following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Science 311.

### **BIO 349P. Pandemic Science.**

Examine the history, spread, mitigation, and forecasting of pandemics. Three lecture hours a week for one semester. Biology 337 (Topic: Pandemic Science) and 349P may not both be counted. Prerequisite: Biology 325 with a grade of at least C-.

### **BIO 350. Developmental, Stem Cell, and Regenerative Biology.**

Explore the principles and mechanisms of embryonic development and the processes guiding stem cell differentiation and tissue repair. Three

lecture hours a week for one semester. Biology 349 and 350 may not both be counted. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 350M. Plant Molecular Biology.**

Fundamentals of plant molecular biology, including structure and expression of the chloroplast and mitochondrial genomes. Three lecture hours a week for one semester. Biology 350M and 388M may not both be counted. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 351. Economic Botany.**

An in-depth analysis of the origin of domesticated plant species, the role in nature of plant products, and the ways natural products have been altered through artificial selection. Three lecture hours a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 352. Reproductive Biology of Flowering Plants.**

Pollination biology, breeding systems, reproductive strategies, and fruit and seed dispersal from evolutionary and ecological vantage points. Three lecture hours a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 353F. Field Entomology.**

A field course on insects, with emphasis on field study techniques, visual identification of species, collecting techniques, and curation in the field. Meets five days a week for one hour a day during a summer-session term; additional fieldwork to be arranged, including extended field trips. Biology 337 (Topic: Field Entomology) and 353F may not both be counted. Prerequisite: The following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Science 311.

### **BIO 453L. Entomology.**

Characteristics, importance, and biology of the major groups of insects. Two lecture hours and three laboratory hours a week for one semester, with additional fieldwork hours to be arranged. Prerequisite: The following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Science 311.

### **BIO 353S. Sleep Science.**

Explore the basics of sleep science. Examine current research questions and novel approaches. Discuss the range of sleep disorders and their diagnoses. Three lecture hours a week for one semester. Biology 337 (Topic 7) and 353S may not both be counted. Prerequisite: For Neuroscience majors, Biology 325 or 325H and Neuroscience 335; for others, Biology 325 or 325H and Psychology 332.

### **BIO 354C. Cell Biology of Human Birth Defects.**

Explores the link between basic cell biology, human genetics, and human birth defects using current scientific literature exposing students to critical thinking and the scientific method, as well as the application of these tools to the study of biology. Three lecture hours a week for one semester. Biology 337 (Topic: Developing Biology) and Biology 354C may not both be counted. Prerequisite: Biology 349 with a grade of at least C-.

### **BIO 354L. Ichthyology.**

Overview of the evolution, biology, and ecology of fishes, emphasizing freshwater fishes. Three lecture hours and three hours of laboratory or fieldwork a week for one semester, with field trips to be arranged. Prerequisite: The following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Science 311.

### **BIO 355. Microbial Biochemistry.**

Study the function of bacterial proteins and their complexes, including their role in inter-bacterial interactions that shape multi-species

communities. Three lecture hours a week for one semester Biology 339 and 355 may not both be counted. Prerequisite: Biology 326R; and Biochemistry 369 or 339F with a grade of at least C-.

### **BIO 455L. Vertebrate Natural History.**

Phylogeny, taxonomy, life histories, habits, and distribution. Two lecture hours and three hours of laboratory or fieldwork a week for one semester, with field trips to be arranged. Prerequisite: The following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Science 311.

### **BIO 356E. Epigenetics and Epitranscriptomics.**

Explore epigenetic mechanisms that involve covalent modifications of the three major biomolecules: DNA, RNA, or proteins in the context of gene expression and genome stability. Examine how environmental and intrinsic factors regulate these mechanisms to impact normal and diseased cell functions, particularly as they relate to human health, aging, and behavior. Three lecture hours a week for one semester. Only one of the following may be counted: Biology 327E, 337 (Topic: Epigenetics), 356E. Prerequisite: Biology 344 with a grade of at least C-.

### **BIO 456L. Limnology and Oceanography.**

Same as Marine Science 440. An introduction to the study of the interactions between aquatic organisms and their environments. Two lecture hours and six laboratory hours a week for one semester. Prerequisite: Chemistry 302, 302C, or 302H; and the following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Science 311.

### **BIO 357. Evolutionary Ecology.**

Principles of modern ecology, particularly as they relate to natural selection and evolutionary theory. Three lecture hours and one discussion hour a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 359J. Behavioral Ecology.**

Advanced topics in behavioral ecology, with detailed consideration of animal communication, altruism, sexual selection, plant-animal interactions. Three lecture hours and one discussion hour a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-, and Biology 359K or 370 with a grade of at least C-.

### **BIO 359K. Principles of Animal Behavior.**

An introduction to the study of animal behavior: descriptive analysis of behavior; physiological basis of behavior; development of behavior; adaptive significance and evolution of behavior; communication and social behavior. Three lecture hours and one discussion hour a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 359R. Animal Sexuality.**

The biology of sexuality, including genetics, morphology, physiology, and psychology of sex. Three lecture hours and one discussion hour a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 360K. Immunology.**

The basic concepts of humoral and cell-associated immune phenomena, including innate immunity, the molecular basis of T cell and B cell antigen recognition, hematopoiesis and the development of lymphocytes, cellular and humoral immune responses and the basics of immunodeficiency, autoimmunity, immunotherapy and vaccination. Three lecture hours a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 260L. Immunology Laboratory.**

Current techniques in experimental cellular and humoral immunology. One hour lecture and four laboratory hours a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-; Biology 206L, 208L, 226L, or Environmental Science 311 with a grade of at least C-; and credit or registration for Biology 360K.

### **BIO 361. Human Infectious Diseases.**

Etiology, pathogenesis, diagnosis, and immunobiology of the major microbial diseases, with emphasis on their prevention. Three lecture hours a week for one semester. Prerequisite: Biology 325 or 325H, and Biology 326M or 326R with a grade of at least C- in each.

### **BIO 361L. Clinical Bacteriology Laboratory.**

Training in techniques required for independent work in diagnostic and epidemiological bacteriology. Two lecture hours and five laboratory hours a week for one semester. Prerequisite: The following with a grade of at least C- in each: Biology 325 or 325H; 226L; and 326R or 326M.

### **BIO 361T. Comparative Animal Physiology.**

Examine the physiology of organ systems in animal phyla, with special emphasis on the neural and behavioral adaptations of organisms to their environment. Three lecture hours and one discussion hour a week for one semester. Only one of the following may be counted: Biology 361 T, Neuroscience 361 T, 337 (Topic: Comparative Animal Physiology). Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 463L. Plant Systematics.**

Principles of plant classification, phylogeny, and diversity as exemplified by families and species of flowering plants found seasonally in Texas with an emphasis on the local flora. Two lecture hours and three laboratory hours a week for one semester, with additional field trips to be arranged. Biology 262 and 262L, and 463L may not both be counted. Prerequisite: The following with grades of at least C-: Biology 325 or 325H; and Biology 206L, 208L, 226L, or Environmental Science 311.

### **BIO 364. Microbial Ecology.**

Population, community, and ecosystem ecology of microbes and microbiomes. Three lecture hours a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 365S. Human Systems Physiology.**

Overview of human physiology, including the cardiovascular, respiratory, and renal systems, with an emphasis on critical thinking, integration, and application. Additional subjects include membrane movement, osmolarity and tonicity, endocrinology, and neurophysiology. Three lecture hours and one discussion hour a week for one semester. Prerequisite: Biology 311C; Biology 325 or 325H, and Chemistry 301, 301C, or 301H with a grade of at least C- in each; and one of the following with a grade of at least C-: Mathematics 408C, 408K, 408N, 408R, or Statistics and Data Sciences 302.

### **BIO 165U. Human Systems Physiology Laboratory.**

Offers hands-on experience in human physiology and encourages critical thinking via case study application. Explores the scientific method through the reading of scientific journal articles; writing protocols for basic physiological experiments; and collecting, analyzing, and presenting data. Three laboratory hours a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-, and credit or registration for Biology 365S.

### **BIO 366. Microbial Genetics.**

Molecular biology of nucleic acids; biosynthesis of macromolecules, transfer of genetic material from cell to cell, recombination, mutagenesis, and regulatory mechanisms. Three lecture hours a week for one

semester. Biology 366 and 391S may not both be counted. Prerequisite: Biology 325 or 325H with a grade of at least C-, and Biology 326R with a grade of at least C-.

### **BIO 366R. Molecular Genetics and Medicine.**

Implementation of molecular genetics techniques in medicine. Includes application of diagnostic and therapeutic techniques for several genetic disorders and infectious diseases. Three lecture hours a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 367C. Cellular and Molecular Bases of Neural Development.**

An introduction to the principles by which the neural tube (brain and spinal cord) forms during embryonic development. Subjects include the cellular and molecular mechanisms underlying the formation of a three-dimensional neural tube and its division into forebrain, midbrain, hindbrain, and spinal cord. Three lecture hours a week for one semester. Biology 365N and BIO 367C may not both be counted. Prerequisite: One of the following with a grade of at least C-: Biology 325, Neuroscience 330, 365R.

### **BIO 068. Peer Assistant.**

May be repeated for credit. Offered on the pass/fail basis only.

### **BIO 369F. Field Herpetology.**

Species identification by sight and sound, and research techniques such as sampling populations, data collection, and analysis. One lecture hour and five laboratory hours a week for one semester, with additional field hours to be arranged. Prerequisite: The following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Science 311.

### **BIO 369L. Herpetology.**

Biology of amphibians and reptiles, including evolution, ecology, behavior, physiology, life history, and identification. Three lecture hours and three laboratory hours a week for one semester. Prerequisite: The following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Science 311.

### **BIO 370. Evolution.**

Introduction to modern evolutionary biology, focusing on the evolution of molecular, developmental, morphological, and behavioral traits. Genetic and ecological bases of evolutionary changes within populations and of evolutionary divergence in animals and plants. Three lecture hours and one discussion hour a week for one semester. Biology 370 and 385K (Topic 2: Evolution) may not both be counted. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 170C, 270C, 370C, 470C. Conference Course.**

Supervised study of selected topics in biology, by individual arrangement with the instructor. Conference course. May be repeated for credit when the topics vary. Prerequisite: Biology 325 or 325H with a grade of at least C-; additional prerequisites vary with the topic.

### **BIO 471. Introduction to Systematics.**

Study of diversification of living and fossil organisms, including speciation, biogeography, taxonomy, and phylogeny of genes, species, and higher taxa. The lecture and laboratory include a significant amount of computational molecular phylogenetics. Three lecture hours and three laboratory hours a week for one semester. Prerequisite: Biology 325 or 325H, and 370 with a grade of at least C-.

### **BIO 471G. Natural History Museum Science.**

An introduction to curatorial practices in natural history museums. Three lecture hours and one discussion hour a week for one semester; students

also complete a twenty- to thirty-hour curatorial project. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 371L. Experimental Physiology.**

Experimental approach to physiological mechanisms by which animals adapt to their environment. One lecture hour, four laboratory hours, and two hours of computer work a week for one semester. Prerequisite: The following with a grade of at least C-: Biology 325 or 325H, and Biology 206L, 208L, 226L, or Environmental Science 311.

### **BIO 372C. Biology Peer Mentors in Research/Teaching.**

Students work as peer mentors and assistants in the teaching of biology, with emphasis on developing instructional materials that teach fundamental biology with real world data. Students mentor students for at least three hours a week in addition to other weekly meetings. Biology 372C and Chemistry 372C may not both be counted. Prerequisite: Biology 311C, 311D, and 325, or Biology 315H and 325H, with a grade of at least B in each; and consent of the undergraduate adviser.

### **BIO 373. Ecology.**

An introduction to ecology, the study of relationships among organisms and between organisms and their environment; adaptations, population, communities, and ecosystems. Includes both plants and animals and both terrestrial and aquatic ecosystems. Three lecture hours and one discussion hour a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 373L. Ecology Laboratory.**

Intensive field ecology. Includes group field experiment and observation, independent projects, and field trips to other vegetation zones. Students complete weekly write-ups of observation and data analysis, reports of independent projects, and an oral presentation on an independent project. Four laboratory hours and two workshop/lecture hours a week for one semester. Prerequisite: Credit with a grade of at least C- or registration for Biology 373; and the following with a grade of at least C-: Biology 206L, 208L, 226L, or Environmental Science 311.

### **BIO 374. Plant Anatomy with Histological Techniques.**

Tissue organization and cellular details of stems, roots, and leaves of seed plants, with emphasis on development and function. Three lecture hours a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-, and concurrent enrollment in Biology 174L.

### **BIO 174L. Laboratory in Plant Anatomy and Histological Techniques.**

Demonstration of cellular details and tissue systems of plant organs; instruction in the preparation of plant materials for histological examination. Three laboratory hours a week for one semester. Prerequisite: Credit with a grade of at least C- or registration for Biology 374; and the following with a grade of at least C-: 206L, 208L, 226L, or Environmental Sciences 311.

### **BIO 375. Conservation Biology.**

Application of principles of ecology to the preservation of wild plant and animal species and to the preservation, management, and restoration of natural and seminatural ecosystems. Emphasis on scientific, biological aspects of issues such as endangered species protection, preserve design, and forest management. Three lecture hours a week for one semester. Prerequisite: Biology 325 or 325H with a grade of at least C-, and Biology 357, 359J, or 373 with a grade of at least C-.

### **BIO 177, 277, 377. Undergraduate Research.**

Laboratory or field research in the various fields of biological science under the supervision of one or more faculty members. Supervised individual research. Up to three semester hours may be counted toward

the major requirement for the Bachelor of Arts degree with a major in biology. May be repeated for credit. Prerequisite: Biology 325 or 325H with a grade of at least C-, and written consent of instructor.

### **BIO 478L. Comparative Vertebrate Anatomy.**

Study of vertebrate morphology from developmental anatomy to the function, biomechanics, and phylogenetic relationships of living and fossil taxa. Three lecture hours and four laboratory hours a week for one semester. Biology 478L and Kinesiology 324K, 424K may not both be counted. Prerequisite: Biology 325 or 325H with a grade of at least C-.

### **BIO 379H, 679H. Honors Tutorial Course.**

Original laboratory or field research project under the direction of a faculty mentor, leading to a thesis or research presentation for students in the honors program in biology. The equivalent of three or six lecture hours a week for one semester. May be repeated for credit, but no more than six hours may be counted toward a degree in biology. Prerequisite: Consent of the student's research supervisor and the departmental honors adviser.

## **Graduate Courses**

### **BIO 380C. Advanced Conservation Biology.**

Application of principles and concepts of ecology to the preservation of wild plant and animal species and to the preservation, management, and restoration of natural and semi-natural ecosystems. Emphasis on biological aspects of issues such as endangered species protection, invasive species, preserve design, and forest management, via a set of case studies. Three lecture hours a week for one semester. Biology 380C and 384K (Topic: Advanced Topics in Conservation Biology) may not both be counted. Prerequisite: Graduate standing.

### **BIO 380E. Advanced Microbial Ecology.**

Examines microbial population, community, and ecosystem ecology. Three lecture hours a week for one semester. Only one of the following may be counted: Biology 380E, 384K (Topic 22), and 384K (Topic: Advanced Topics in Microbial Ecology). Prerequisite: Graduate standing.

### **BIO 380F. Biology of Birds.**

Anatomy, physiology, classification, and ecology of birds. Three lecture and two laboratory hours a week for one semester. Includes optional weekly, half-day field trips and two optional full-weekend trips. Biology 384K (Topic: Biology of Birds) and 380F may not both be counted.

### **BIO 380G. Methods in Ecological Genomics.**

Explores state-of-the-art methodologies for: genomics-based demographic and population structure analysis; detection of genomic signatures of natural selection; analyzing gene expression in the ecology, evolution, and behavior context; quantification of complex communities using metabarcoding. Three lecture hours a week for one semester. Biology 380G and 384K (Topic: Methods in Ecological Genomics) may not both be counted. Prerequisite: Graduate standing.

### **BIO 380L. Advanced Systematics.**

Explores biodiversity, phylogeny, species concepts, historical biogeography, phylogeography, molecular clocks, phylogenomics, comparative methods, fossils, morphometrics, taxonomy, ontogeny, homology, computational methods, and phylogenetic statistics. Three lecture hours and three laboratory hours a week for one semester. Biology 384K (Topic 14) and 380L may not both be counted. Prerequisite: Graduate standing.

### **BIO 380M. Topics in Biology (Cooperative Programs).**

Formal, organized courses taught at institutions other than the University of Texas at Austin. Three lecture hours a week for one semester. Not all topics are offered every year. May be repeated for credit when the

topics vary. Prerequisite: Graduate standing, consent of the student's graduate adviser or department chair and the University's graduate dean, and consent of the graduate dean at the host institution; additional prerequisites vary with the topic.

### **BIO 380P. Population Genetics.**

Introduces students to population genetics. The emphasis is on a quantitative understanding of evolutionary change caused by selection, drift, mutation, and migration. Both phenotypic and molecular evolution will be covered. Three lecture hours a week for one semester. Biology 380P and 385K (Topic 4) may not both be counted.

### **BIO 180R, 280R, 380R. Advanced Readings in the Biological Sciences.**

For each semester hour of credit earned, the equivalent of one class hour a week for one semester. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

### **BIO 380S. Animal Sexuality.**

Examines how hormones shape the development of the body, regulate physiological processes, and influence how individuals behave. Three lecture hours a week for one semester. Meets requirements for non-seminar graduate courses in the Ecology, Evolution, and Behavior Graduate Program. Only one of the following may be counted: Biology 380S, 383K (Topic: Animal Sexuality), 383K (Topic: Studies in Animal Sexuality). Prerequisite: Graduate standing.

### **BIO 380T. Current Concepts in Biology.**

Designed for beginning graduate students seeking a review of modern biological concepts. Three lecture hours a week for one semester. With consent of instructor, may be repeated for credit when the topics vary. Prerequisite: Graduate standing in the School of Biological Sciences, and consent of instructor and the graduate adviser.

### **BIO 380U. Brain, Behavior, and Evolution.**

Same as Neuroscience 380U. Integrative approaches to the study of brain and behavior within an evolutionary and comparative framework. Specifically, the integration of neuroscience, organismal behavior and physiology, behavioral ecology, evolutionary development, experimental evolution, molecular biology, genetics, genomics, systems biology, and bioinformatics. Three lecture hours a week for one semester. Only one of the following may be counted: Biology 380U, 384K (Topic: Brain, Behavior, and Evolution), Neuroscience 380U, 385L (Topic: Brain, Behavior, and Evolution). Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

### **BIO 380V. Biological Foundations of Decision Making.**

Same as Neuroscience 380V. Explores the mechanisms biological organisms use to make decisions and how these mechanisms evolved. Defines a conceptual framework for decision making that can be applied across levels of biological organization. Surveys current research on how animals make decisions using genetic, neurobiological, and evolutionary approaches. Three lecture hours a week for one semester. Only one of the following may be counted: Biology 380V, 384K (Topic: Biological Foundations of Decision Making), Neuroscience 380V, 385L (Topic: Biological Foundations of Decision Making). Prerequisite: Graduate standing.

### **BIO 381. Advanced Plant Physiology.**

Concepts in the broad field of plant physiology. Includes aspects of plant growth, development, cell signaling, and stress responses that are very similar to these processes in animals, but will also illustrate unique aspects of plants that exemplify the diversity of life strategies on earth. Explores the critical skills needed to evaluate the current literature, data interpretation, and methods for solving key questions in the field. Three

lecture hours a week for one semester. Only one of the following may be counted: Biology 381, 389 (Topic: Advanced Plant Physiology), and 389 (Topic 12). Prerequisite: Graduate standing.

### **BIO 381E. Ecology Seminar.**

Listen to and discuss presentations ranging from research progress reports to practice conference talks and well-versed presentations of long term research programs. Three lecture hours a week for one semester. Biology 381E and 384K (Topic: Ecology Seminar) may not both be counted. May be repeated for credit. Offered on the credit/no credit basis only. Prerequisite: Graduate standing, consent of the graduate adviser, and consent of instructor.

### **BIO 381K. Ecology, Evolution, and Behavior: Physiology and Biophysics.**

Lectures, conference discussion, and laboratory projects, depending on topic. Not all topics are offered every year. May be repeated for credit when the topics vary. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser; additional prerequisites vary with the topic.

**Topic 1: Topics in Biophysics.** Irritability of living systems and the principles of energy transformation and transfer in organisms; emphasis on bioelectrical processes and electrical energy changes. Three lecture hours a week for one semester.

**Topic 2: Comparative Neurophysiology.** General treatment of the physiology of neurons, synapses, sensory and motor systems; neural basis of behavior; emphasis on invertebrates. Three lecture hours a week for one semester.

**Topic 3: Sensory Physiology.** Physiology and biophysics of the transduction and peripheral processes of the major sensory systems. Three lecture hours a week for one semester.

**Topic 4: Current Concepts in Neurobiology.** A series of seminars designed to give students a broad background in neurobiology. Three lecture hours a week for one semester.

**Topic 5: Laboratory in Neurophysiology.** Training in research techniques useful for the neurophysiological study of vertebrate and invertebrate nervous systems. Three lecture hours a week for one semester.

**Topic 6: Insect Physiology.** An in-depth study of the physiology of insect organ systems, development, and behavior. Three lecture hours a week for one semester.

**Topic 7: Developmental Neurobiology.** Neuronal cell lineage and differentiation, neuronal migration, axon guidance, neural cell death, synapse formation and maintenance. Three lecture hours a week for one semester.

**Topic 8: Addiction Biology.** Three lecture hours a week for one semester. Biology 381K (Topic 8) and Neuroscience 385L (Topic 3: Addiction Biology) may not both be counted.

**Topic 9: Comparative Animal Physiology.** Examine the physiology of organ systems in animal phyla, with special emphasis on the neural and behavioral adaptations of organisms to their environment. Three lecture hours a week for one semester.

**Topic 11: Current Concepts in Neurophysiology.** Three lecture hours a week for one semester.

### **BIO 381N. Basic Processes of Nerve Cells.**

Same as Neuroscience 381N. Degeneration and regeneration in nervous systems following traumatic injury; invertebrate versus vertebrate, peripheral nervous system versus central nervous system, axonal versus cell body, role of glia versus neurons. Three lecture hours a week for one semester. Only one of the following may be counted: Biology 381K (Topic 10), 381N, Neuroscience 381N, 385L (Topic 1). Prerequisite: Graduate standing.



### **BIO 381P. Advanced Plant Physiology.**

General principles of mineral nutrition, water relations, metabolic activities, growth and development of green plants. Biology 381P and 389 (Topic 12) may not both be counted.

### **BIO 182, 282, 382, 682, 982. Advanced Study and Research.**

For each semester hour of credit earned, the equivalent of one class hour a week for one semester. May be repeated for credit. Prerequisite: Graduate standing and consent of instructor and the graduate adviser.

### **BIO 382E. Epigenetics.**

Same as Neuroscience 382E. Study of how epigenetic modifications are covalent modifications of DNA or histones that cause changes in gene expression and how epigenetic modifications appear to be a method through which nurture or the environment can influence nature. Emphasis on how experience or environmental factors epigenetically modify health or behavior of animals. Three lecture hours a week for one semester. Only one of the following may be counted: Biology 381K (Topic: Epigenetics), 382E, Neuroscience 382E. Offered on the letter-grade basis only. Prerequisite: Graduate standing and consent of instructor.

### **BIO 382K. Computational and Statistical Biology.**

Three lecture hours a week for one semester. May be repeated for credit when the topics vary.

**Topic 1: Recent Advances in Computational Biology.** Discussion of current scientific papers, methods, and ideas in computational biology and bioinformatics.

**Topic 2: Network Modeling in Biology.**

**Topic 3: Modeling Infectious Disease Dynamics.**

**Topic 4: Current Subjects in Biological Statistics.** Emphasis on the practical aspects of data management and analysis, including programming in R and related tools. Subjects may include general linear models, multivariate statistics, Bayesian statistics, model selection, and graphical presentation of data. The equivalent of three lecture hours a week for one semester. Additional prerequisite: At least one prior course in probability or statistics, at the undergraduate level or above.

**Topic 5: Informatics and Data Analysis in Life Sciences.** Introduction to concepts and methods of data-driven life science. Three lecture hours a week for one semester.

**Topic 6: Programming for Biology.** Explores programming skills that are relevant to research in the biological sciences, including but not limited to programming in Python, R, Perl, C++. Three lecture hours a week for one semester.

**Topic 7: Ecological Theory and Modeling.** Explores concepts and methods of modeling ecological systems including populations, communities and ecosystems. Focus on the methodology and utility of ecological theory and modeling. Examines the basic techniques and classic insights derived from differential equation, statistical, and individual based models. The ability to interpret and evaluate models in the literature will be emphasized.

**Topic 8: Introduction to Biology for Data Science.** Explore biological concepts and methods (including its assumptions and limitations), particularly in the areas of systems biology, medical and evolutionary genomics, and neuroscience. Focus on approaches that produce a lot of data but are analysis-challenged. Biology 382K (Topic: Intro to Bio for Data Science) and 382K (Topic 8) may not both be counted.

### **BIO 383K. Ecology, Evolution, and Behavior: Development and Reproduction.**

Three lecture hours a week for one semester, or as required by the topic. Not all topics are offered every year. May be repeated for credit when the

topics vary. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

**Topic 1: Hormonal Control of Development and Reproduction.** Three lecture hours a week for one semester.

**Topic 2: Techniques in the Study of Development and Reproduction.** Eight laboratory hours a week for one semester.

**Topic 3: Comparative Endocrinology.** Structure, function, and interrelationships of endocrine glands, with emphasis on the control of hormone synthesis and secretion and mechanisms of hormone action. Three lecture hours a week for one semester.

**Topic 4: Recent Advances in Development and Reproduction.**

Discussion of recent scientific papers and their contribution to modern work in development and reproduction. Three lecture hours a week for one semester.

**Topic 5: Molecular Analysis of Development.** Lectures and discussion concerning the principles of animal development at the molecular level. Three lecture hours a week for one semester.

**Topic 8: Development and Evolution.** Three lecture hours a week for one semester.

**Topic 9: Survey of Animal Development.** Three lecture hours a week for one semester.

### **BIO 384C. Subjects and Skills in Ecology, Evolution, and Behavior I.**

Designed for first-year graduate students in ecology, evolution, and behavior. Study of why animals behave the ways they do. Study of the proximate and ultimate issues of animal behavior, how it is acquired and regulated, and how it evolved. Emphasis on integration of proximate and ultimate analyses in the various domains in which animals behave. First part of a two-semester sequence. Three lecture hours and one discussion hour a week for one semester. Biology 384C and 389D may not both be counted. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

### **BIO 384D. Subjects and Skills in Ecology, Evolution, and Behavior II.**

Designed for first-year graduate students in ecology, evolution, and behavior. Continuation of the study of why animals behave the way they do. Continued overview of both the proximate and ultimate issues of animal behavior, how it is acquired and regulated, and how it evolved. Emphasis on integration of proximate and ultimate analyses in the various domains in which animals behave. Second part of a two-semester sequence. Three lecture hours and one discussion hour a week for one semester. Biology 384D and 389E may not both be counted. Prerequisite: Graduate standing, Biology 384C, and consent of instructor and the graduate adviser.

### **BIO 384K. Ecology, Evolution, and Behavior.**

Basic concepts and methods of laboratory and field analysis in various fields of biology; systematics and ecology of natural populations. Lectures, conference discussions, and laboratory work, depending on topic. May be repeated for credit when the topics vary. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser; additional prerequisites vary with the topic.

**Topic 29: Recent Advances in Population Ecology.** Seminar course; some written assignments required. Faculty- and student-led discussions of current subjects in population ecology. Three lecture hours a week for one semester. Additional prerequisite: Undergraduate upper-division ecology course (Biology 373 or similar course).

**Topic 30: Recent Advances in Community Ecology.** Seminar course. Faculty- and student-led lectures and discussions of current topics in community ecology. Some written assignments required. Three lecture hours a week for one semester. Additional prerequisite:

Undergraduate upper-division ecology course (Biology 373 or similar course) required.

**Topic 31: Recent Advances in Ecosystem Ecology.** Seminar course.

Faculty- and student-led lectures and discussions of current topics in ecosystem ecology. Some written assignments required. Three lecture hours a week for one semester. Additional prerequisite: Undergraduate upper-division ecology course (Biology 373 or similar course).

**Topic 32: Recent Advances in Macroecology.** Examines recent ideas and new findings in the fields of Macroecology, Biogeography, and Ecosystem Science. Three lecture hours a week for one semester.

**Topic 33: Recent Advances in Conservation Biology.** Seminar course. Faculty- and student-led discussions of current topics in population ecology. Some written assignments may be required. Three lecture hours a week for one semester. Additional prerequisite: Undergraduate upper-division ecology course (Biology 373 or similar course); undergraduate upper-division evolution course recommended.

**Topic 34: Recent Advances in Microbial Ecology.** Explores current subjects and controversies in microbial ecology, including community and ecosystem perspectives. Includes faculty- and student-led discussions of primary literature. Some written assignments required. Three lecture hours a week for one semester.

**Topic 35: Global Environmental Change.** Explores the knowledge of current environmental change and biological responses, efforts to understand and predict changes in the future through both experimental manipulations and models. Discussion of the scientific philosophy behind this work. Three lecture hours a week for one semester. Additional prerequisite: Undergraduate upper-division ecology course (Biology 373 or similar course); undergraduate upper-division evolution course recommended.

**Topic 36: Recent Advances in Evolution.** Examines recent and classic research and primary literature concerning general subjects within evolutionary biology. Three lecture hours a week for one semester. Additional prerequisite: Undergraduate upper-division evolution course (Biology 370 or similar course).

**Topic 37: Recent Advances in Coevolution.** Examines current and classic literature related to the coevolution of interacting species, including but not limited to host-parasite interactions, and mutualistic interactions. Three lecture hours a week for one semester.

**Topic 38: Recent Advances in Ecological and Evolutionary Genetics.** Discussion and analysis of current and classic literature related to ecological and evolutionary genetics. Three lecture hours a week for one semester.

**Topic 39: Phylogenetic Perspectives in Ecology, Evolution, and Behavior.** Theory, methods, and applications of phylogenetics in ecology, evolution, and behavior. The development of phylogenetics; the various phylogenetic optimality criteria and their advantages and disadvantages (include non-parametric, semi-parametric, and parametric methods); models of evolution for molecular and morphological data; algorithms and heuristics for searching solution space, including discussion of Bayesian Markov chain Monte Carlo approaches; phylogenetic simulation; statistical assessment of phylogenetic results; molecular clocks; and major applications of phylogenetics. Three lecture hours a week for one semester.

**Topic 40: Recent Advances in Biogeography and Phylogeography.** Reviews concepts and recent literature in Biogeography, Phylogeography, or Macroecology. Three lecture hours a week for one semester.

**Topic 41: Recent Advances in Molecular and Genomic Evolution.** Three lecture hours a week for one semester. Additional prerequisite: Undergraduate upper-division evolution course (Biology 370 or similar course).

**Topic 42: Human and Primate Evolutionary Genetics.** Three lecture hours a week for one semester. Anthropology 388 (Topic: Human/Primate Evolut Genetics) and Biology 384K (Topic 42) may not both be counted.

**Topic 43: Ancient and Environmental DNA.** Explores the prospects and challenges of ancient/environmental DNA research, and considers the applications in evolutionary biology, paleontology, and anthropology. Three lecture hours a week for one semester. Only one of the following may be counted: Anthropology 388 (Topic: Ancient DNA) Biology 384K (Topic: Ancient DNA), 384K (Topic 43).

**Topic 44: Recent Advances in Behavior.** Explores recent and classic research and primary literature concerning general topics within behavioral ecology, and the evolution of behavior. Three lecture hours a week for one semester.

**Topic 45: Seminars in Brain Behavior and Evolution.** Explores how to give a seminar and/or writing a grant proposal. Preparation for job talks, paper presentations, or writing grants.

### **BIO 384L. Issues in Population Biology.**

Analysis at an advanced level of currently active areas of research in population biology. Three lecture hours a week for one semester. Offered on the credit/no credit basis only. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

### **BIO 386. Topics in Plant Science: Ecology and Evolution.**

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser; additional prerequisites vary with the topic.

**Topic 10: Recent Advances in Plant Systematics.** Basic concepts and methods of laboratory and field analysis in various fields of biology; systematics and ecology of natural populations.

**Topic 11: Advanced Subjects in Plant Ecology.**

**Topic 12: Advanced Subjects in Plant Evolution.**

**Topic 13: Advanced Subjects in Plant Molecular Biology.**

### **BIO 386K. Plant Sciences.**

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing.

**Topic 1: Advanced Subjects in Plant Ecology.** Seminar course with faculty- and student-led lectures and discussions of current subjects in plant ecology. Additional prerequisite: Undergraduate upper-division ecology course (Biology 373 or similar course).

**Topic 2: Advanced Subjects in Plant Evolution.** Seminar course with faculty- and student-led lectures and discussions of current subjects in plant evolution. Additional prerequisite: Undergraduate upper-division evolution course (Biology 370 or similar course).

**Topic 3: Advanced Subjects in Plant Systematics.**

**Topic 4: Advanced Subjects in Plant Molecular Biology.** Seminar course with faculty- and student-led lectures and discussions of current subjects in plant molecular biology. Additional prerequisite: Undergraduate upper-division ecology course (Biology 373 or similar course).

### **BIO 386P. Foundations of Plant Biology.**

Restricted to students in the plant biology graduate program. Study of foundational ideas across the breadth of plant biology. Three lecture hours a week for one semester. Offered on the credit/no credit basis only. Prerequisite: Graduate standing, and consent of the instructor and the graduate adviser.

### **BIO 287F. Plant Systematics.**

Principles of plant taxonomy, as exemplified by families of flowering plants found seasonally around Austin. Two lecture hours a week for one semester. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

**BIO 487G. Taxonomic Plant Anatomy.**

An advanced course that emphasizes those aspects of plant anatomy that are most reliable and useful for systematic purposes. Three lecture hours and two laboratory hours a week for one semester. Biology 472L and 487G may not both be counted. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

**BIO 387J. Advanced Plant Anatomy.**

Plant anatomy in relation to development and differentiation, systematics, and evolution. Three lecture hours a week for one semester. Prerequisite: Graduate standing, consent of instructor and the graduate adviser, and concurrent enrollment in Biology 187L.

**BIO 387K. Plant Evolution.**

The properties of plant populations, considered from genetic and ecological perspectives; mechanisms of evolution within and among populations. Three lecture hours a week for one semester. May be repeated for credit. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

**BIO 187L. Laboratory in Advanced Plant Anatomy.**

Demonstration of cellular details and tissue systems of plant organs, and instruction on the preparation of plant materials for histological examination. Three laboratory hours a week for one semester. Prerequisite: Graduate standing, consent of instructor and the graduate adviser, and concurrent enrollment in Biology 387J.

**BIO 387M. Reproductive Biology of Flowering Plants.**

Pollination biology, breeding systems, and fruit and seed dispersal from evolutionary and ecological vantage points. Three lecture hours a week for one semester. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

**BIO 387N. Plant Ecology.**

Advanced topics in plant ecology, including evaluation of ecological concepts, aspects of experimental ecology, and the principles of plant distribution. Three lecture hours a week for one semester. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

**BIO 187P. Plant Ecology Laboratory.**

Demonstrations and experiments stressing plant ecological principles, including laboratory and field exercises. Three laboratory hours a week for one semester. Prerequisite: Graduate standing, consent of instructor and the graduate adviser, and credit or registration for Biology 387N.

**BIO 387R. Population Ecology of Plants.**

A combination of lectures and student-led discussions covering major concepts and current literature in plant population ecology. Three lecture hours a week for one semester. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

**BIO 387S. Laboratory Methods in Molecular Ecology and Systematics.**

An introduction to DNA methods in the study of molecular ecology, systematics, and evolution: DNA isolation and purification; DNA quantification; polymerase chain reaction; restriction fragment length polymorphism; random amplified polymorphic DNA; amplified fragment length polymorphism; cloning; simple sequence repeat (microsatellite) marker development; DNA sequencing; automated sequencing; automated genotyping; phylogenetic and population genetic analyses. Seven laboratory hours a week for one semester. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

**BIO 287T. Angiosperm Diversity Laboratory.**

Practical experience in recognizing, identifying, and classifying families of flowering plants. Four laboratory hours a week for one semester. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

**BIO 388C. Transmembrane Signaling Mechanisms.**

Mechanisms by which hormones, light, and other stimuli trigger changes in plant and animal cell metabolism. Three lecture hours a week for one semester. Biology 343M and 388C may not both be counted. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

**BIO 388D. Research Topics in Plant Biology.**

An introduction to various fields of plant biology. Students attend seminars, faculty research presentations, and other meetings. Three lecture hours a week for one semester, with additional meeting times to be arranged. Prerequisite: Graduate standing in the School of Biological Sciences.

**BIO 388E. Plant Growth and Development.**

Emphasis on whole plant physiology, especially growth and development, water relations, and mineral nutrition of vascular plants. Three lecture hours a week for one semester. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

**BIO 388J. General Phycology.**

Survey of the algae, including significant biological aspects of selected genera, research techniques, and readings in the literature. Three lecture hours a week for one semester. Biology 327 and 388J may not both be counted. Prerequisite: Graduate standing, consent of instructor and the graduate adviser, and concurrent enrollment in Biology 188K.

**BIO 188K. Laboratory in General Phycology.**

Survey of various algal groups, including direct observations of their biology, exposure to research techniques, and instruction in cultural procedures. Three laboratory hours a week for one semester. Prerequisite: Graduate standing, consent of instructor and the graduate adviser, and concurrent enrollment in Biology 388J.

**BIO 388L. Laboratory Studies in Cell Biology: Plant Biology.**

Research exercises involving light microscopy, including polarization, phase contrast, Nomarski interference, dark field, fluorescence, and bright-field optics. High-resolution transmission electron microscopy. Hands-on experience with atomic and molecular imaging, including digital image processing and time-lapse video microscopy. One lecture hour and four laboratory hours a week for one semester. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

**BIO 388M. Plant Molecular Biology.**

Fundamentals of plant molecular biology, including structure and expression of the chloroplast and mitochondrial genomes. Three lecture hours a week for one semester. Biology 350M and 388M may not both be counted. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

**BIO 389C. Chemistry and Biology of Membranes.**

Consideration of the origin and structure of biological membranes at the microscopic and molecular levels; describes membrane function, especially with regard to transport properties. Three lecture hours a week for one semester. Prerequisite: Graduate standing and consent of instructor and the graduate adviser.

### **BIO 389D. Subjects and Skills for Graduate Students in the Biological Sciences.**

Designed for first-year graduate students in ecology, evolution, and behavior. Provides training in many of the skills required of research scientists. Introduction to the writing, presentation and appraisal skills needed to excel in all fields of biological research. Three lecture hours a week for one semester. Biology 384C and 389D may not both be counted. Prerequisite: Graduate standing, and consent of instructor and graduate adviser.

### **BIO 389E. Subjects and Skills for Graduate Students in the Biological Sciences II.**

Explores the general subjects and skills required of research scientists, with an emphasis on the research, teaching, and service skills needed by professional biologists, as well as on the major research themes and questions in ecology, evolution, and behavior. Builds on the writing skills developed in Biology 389D to include issues of ethical behavior in research, effective presentation of results, oral presentation skills, interacting with the media, work-life balance, and public outreach. Three lecture hours a week for one semester. Biology 384D and 389E may not both be counted. Prerequisite: Graduate standing, Biology 389D, and consent of instructor and graduate adviser.

### **BIO 389K. Advanced Cell Biology.**

Three lecture hours a week for one semester. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

### **BIO 190, 290. Topics in Microbiology.**

Discuss current topics in microbiology. For each semester hour of credit earned, one lecture hour a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing and consent of instructor.

### **BIO 390C. Fundamentals of Evolution.**

Introduction to major principles and questions in evolutionary biology. Subjects include population genetics, genetic diversity, adaptation, origin of species, phylogenetics, molecular evolution, and macroevolution. Emphasis on identifying open questions, analysis and interpretation of data, and gaining familiarity with the primary scientific literature. Three lecture hours a week for one semester. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

### **BIO 390D. Fundamentals of Integrative Animal Behavior.**

Introduction to major principles and questions in animal behavior with emphasis on why animals behave the way they do. Study of both the proximate and ultimate issues of animal behavior, how it is acquired and regulated, and how it evolved. Emphasis on integration of proximate and ultimate analyses in the various domains in which animals behave. Three lecture hours a week for one semester. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

### **BIO 390E. Fundamentals of Ecology.**

Fundamentals of ecology, ranging from organism physiology to population, species, community, and ecosystem-level processes across landscapes and biomes. Three lecture hours a week for one semester. Prerequisite: Graduate standing and consent of instructor.

### **BIO 890G. Applied Public Health and Medical Microbiology.**

One semester (or one summer session) of full-time training in the Texas Department of Health Laboratories, with rotation in the divisions of medical microbiology, mycology, parasitology, virology, sanitary bacteriology, and biologics. Assigned reading and regular meetings with the Department of Health Laboratories staff and the molecular genetics and microbiology faculty. Forty hours of supervised fieldwork a week for one semester. Prerequisite: Graduate standing, consent of instructor

and the graduate adviser, and courses in immunology, public health bacteriology, and virology.

### **BIO 290K. Scanning Electron Microscopy, Theory and Practice.**

Theory of scanning electron microscopy and basic principles of instrument design; basic procedures in specimen preparation; hands-on experience. Two lecture hours and six laboratory hours a week for six weeks. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

### **BIO 490M. Electron Microscopy I: Theory and Practice.**

An introduction to electron optics; emphasis on basic operation and maintenance of the transmission microscope; theory and practice of basic preparative techniques. Two lecture hours and six laboratory hours a week for one semester. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

### **BIO 390P. Techniques in Molecular Genetics.**

Laboratory training in modern molecular genetics, with emphasis on the manipulation of bacterial plasmid DNA as a model system. DNA purification, gene mapping and cloning, site-directed mutagenesis, polymerase chain reaction, and DNA sequencing. One lecture hour and seven laboratory hours a week for one semester. Biology 368L and 390P may not both be counted. Prerequisite: Graduate standing, consent of instructor and the graduate adviser, and Biology 366.

### **BIO 391. Grant Writing and Presentation Skills.**

Restricted to second-year graduate students in the microbiology and cell and microbiology programs. Preparation of a detailed proposal of the dissertation research goals of each student with a presentation in the form of a short talk. Emphasis on critical evaluation of research aims, methodology, and communication skills. Designed for second-year doctoral students in biology. Three lecture hours a week for one semester. Biology 391 and 394 (Topic: Grant Writing and Presentation Skills) may not both be counted. Offered on the letter-grade basis only. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser.

### **BIO 391K. Cellular Immunology.**

Cell-associated immune responses, with emphasis on transplantation, immunity, tumor immunology, delayed hypersensitivity, and acquired cellular resistance. Three lecture hours a week for one semester. Prerequisite: Graduate standing, consent of instructor and the graduate adviser, and Biology 360K and 260L.

### **BIO 391P. Advanced Virology.**

Replication of and transformation by DNA and RNA animal viruses. Three lecture hours a week for one semester. Prerequisite: Graduate standing, consent of instructor and the graduate adviser, and Biology 330.

### **BIO 391R. Advanced Metabolism and Biochemistry of Microorganisms.**

Study of the metabolic processes of microorganisms, using a biochemical approach. Three lecture hours a week for one semester. Biology 339 and 391R may not both be counted. Prerequisite: Graduate standing and consent of instructor and the graduate adviser.

### **BIO 391S. Microbial Genetics.**

Molecular biology of nucleic acids; biosynthesis of macromolecules, transfer of genetic material from cell to cell, recombination, mutagenesis, and regulatory mechanisms. Three lecture hours a week for one semester. Biology 366 and 391S may not both be counted. Prerequisite: Graduate standing and consent of instructor and the graduate adviser.

### **BIO 392. Problems in Host-Parasite Biology.**

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser; additional prerequisites vary with the topic.

**Topic 1: Current Topics in Virology and Immunology.**

**Topic 2: Current Topics in Pathogenic Mechanisms.**

### **BIO 392D. DNA Repair.**

Broad overview of the repair of DNA in archae, prokaryotes, eukaryotes, and viruses, focusing on the primary research literature, and developing critical thinking and presentation skills. Three lecture hours a week for one semester. Biology 392D and Biology 393 (Topic: DNA Repair) may not both be counted. Prerequisite: Graduate standing.

### **BIO 393. Problems in Molecular Genetics.**

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser; additional prerequisites vary with the topic.

**Topic 1: Current Topics in DNA Transactions.**

**Topic 2: Current Topics in Fungal and Cell Molecular Biology.**

**Topic 3: Current Topics in Gene Regulation.**

### **BIO 394. Problems in Microbial Physiology.**

Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser; additional prerequisites vary with the topic.

**Topic 1: Current Topics in Cell Envelope Structure and Functions.**

**Topic 2: Current Topics in Microbial Signal Transduction.**

### **BIO 394L. Immunology.**

Introduction to the immune system for graduate students without prior coursework in immunology. Discuss innate immunity, the molecular basis of T cell and B cell antigen recognition, hematopoiesis and the development of lymphocytes, and cellular and humoral immune responses. Touch on immunodeficiency, autoimmunity, immunotherapy and vaccination. Explore current primary literature on select immunological topics in greater depth. Three lecture hours a week for one semester. Biology 394L and 394M (Topic 1) may not both be counted. Prerequisite: Graduate standing, consent of instructor, and consent of the graduate adviser.

### **BIO 394M. Advanced Studies in Microbiology.**

In-depth study of microbiology topics. Students read original research papers in addition to text assignments. Three lecture hours a week for one semester. May be repeated for credit when the topics vary. Prerequisite: Graduate standing, and consent of instructor and the graduate adviser; additional prerequisites vary with the topic.

**Topic 2: Advanced Microbial Signal Transduction.** Studies in molecular and cellular biology of a wide variety of signal transduction systems in diverse microorganisms; the role of signal transduction across biological membranes in allowing cells to recognize and respond to their environment.

**Topic 3: Advanced Medical Mycology.** Studies in medical mycology and an overview of research involving both the fungal zoopathogen and its host.

**Topic 4: Advanced Fungal Cell and Molecular Biology.** Studies of the structure, function, and biological activities of fungi, with emphasis on recent advances in research.

**Topic 5: Microbes, Infectious Disease, and Immunology.** Restricted microbiology, cell and molecular biology, and biochemistry majors. Examine microbes, infectious disease, and immunology in-depth. Read, discuss and present original research papers.

### **BIO 394T. Tumor Biology.**

Explore core aspects of cancer pathology, treatment, epidemiology, the discovery of oncogenes and tumor suppressors, and the molecular genetics underlying the characteristic features of malignant tumors (including metastatic behavior, genomic instability, angiogenesis, cell cycle regulation, and apoptosis). Emphasize the biochemical functions of cancer-related proteins and enzymes and therapeutic approaches based on understanding of these proteins. Examine important experimental approaches that have influenced the current understanding of cancer. Three lecture hours a week for one semester. Biology 384M (Topic: Tumor Biology) and 394T may not both be counted. Prerequisite: Graduate standing; consent of instructor and the graduate adviser

### **BIO 395F. Genetics.**

Same as Chemistry 395F and Molecular Biology 395F. Basic principles of Mendelian and molecular genetics, and an exploration of the genetic toolbox using examples of analytic methods and modern genetic manipulations. Focus on the genetic analysis of model organisms. Use of genetic tools in dissecting complex biological pathways, developmental processes, and regulatory systems. Three lecture hours a week for one semester. Prerequisite: Graduate standing. An introductory course in genetics, such as Biology 325, is strongly recommended.

### **BIO 395G. Structure and Function of Proteins and Membranes.**

Same as Biochemistry 395G and Molecular Biology 395G. Explore advanced biochemistry concepts and the scientific process. Examine a detailed consideration of the structure and function of proteins, carbohydrates, lipids and nucleic acids, as well as discussion of enzyme mechanisms and kinetics. Three lecture hours a week for one semester. Only one of the following may be counted: Biochemistry 395F, 395G, Biology 395I, 395G, Molecular Biology 395I, 395G. Prerequisite: Graduate standing; a one-year undergraduate sequence in biochemistry is strongly recommended.

### **BIO 395H. Cell Biology.**

Same as Chemistry 395H and Molecular Biology 395H. Detailed consideration of mechanisms of growth control, cell cycle regulation, mitosis, cell signaling, protein targeting, and the integration of these processes. Three lecture hours a week for one semester. Prerequisite: Graduate standing; and consent of instructor or Biology 395F and 395G, Chemistry 395F, Molecular Biology 395F and 395G.

### **BIO 395I. Advanced Biochemistry.**

Same as Biochemistry 395F and Molecular Biology 395I. Explore advanced biochemistry concepts and the scientific process. Consider the structure and function of proteins, carbohydrates, lipids and nucleic acids, and discuss enzyme mechanisms and kinetics. Three lecture hours a week for one semester. Only one of the following may be counted: Biochemistry 395F, 395G, Biology 395I, 395G, Molecular Biology 395I, 395G. Prerequisite: Graduate standing; a one-year undergraduate sequence in biochemistry is strongly recommended.

### **BIO 395J. Genes, Genomes, and Gene Expression.**

Same as Biochemistry 395J and Molecular Biology 395J. Detailed consideration of prokaryotic and eukaryotic mechanisms of DNA replication and transcription; posttranscriptional processing of transcription products; and mechanism and regulation of the translation of messenger RNAs. Three lecture hours a week for one semester. Only one of the following may be counted: Biochemistry 395J, Biology 395J,

Molecular Biology 395J. Prerequisite: Graduate standing; and Biology 395F and 395G, or Chemistry 395F and 395G, or Molecular Biology 395F and 395G, or consent of instructor.

#### **BIO 395L. Laboratory Studies in Molecular Biology.**

Explore modern molecular biology with a research project focus in a laboratory setting. Use methods such as eukaryotic RNA purification, quantitative PCR, CRISPR or site-directed mutagenesis cloning, cell fractionation, protein purification and Western blotting detection toward experimental goals. One lecture hour and six laboratory hours a week for one semester. Biology 395 and 395L may not both be counted.

#### **BIO 395M. Advanced Microbiology.**

Restricted to microbiology students. Prokaryotic and lower eukaryote genome organization; control of gene/operon/regulon expression; chromosome replication and its control; signal transduction; protein trafficking; organelle assembly; the cell cycle and its control; developmental processes; cell to cell communication; and DNA polymorphisms and adaptation. Three lecture hours a week for one semester. Prerequisite: Graduate standing and consent of instructor and the graduate adviser.

#### **BIO 396. Membranes and Walls of Bacteria.**

Structure, biosynthesis, and function of bacterial envelopes and walls, including associated optional components. Three lecture hours a week for one semester. Prerequisite: Graduate standing, consent of instructor and the graduate adviser, and a course in general microbiology and a course in general biochemistry.

#### **BIO 396R. Microbiology Research Seminar.**

Students present their research findings and receive feedback from faculty and peers. Designed to help students refine their presentation techniques, practice giving critical feedback, and gain familiarity with a wide variety of research topics. Three lecture hours a week for one semester. Prerequisite: Graduate standing.

#### **BIO 197. Seminar in Microbiology.**

One lecture hour a week for one semester. Required of all molecular genetics and microbiology majors. May be repeated for credit. Offered on the credit/no credit basis only. Prerequisite: Graduate standing and consent of instructor and the graduate adviser.

#### **BIO 397J. Advanced Genetics.**

Intended mainly for first- and second-year graduate students. Selected related topics of current interest with an emphasis on molecular developmental genetics, and any needed review of classical genetics. Designed to help the student to read the literature critically, deliver a good seminar, and participate in thoughtful discussion. Three lecture hours a week for one semester. May not be counted toward the doctoral degree in microbiology. Prerequisite: Graduate standing, consent of instructor and the graduate adviser, and a course in genetics.

#### **BIO 698. Thesis.**

The equivalent of three lecture hours a week for two semesters. Offered on the credit/no credit basis only. Prerequisite: For 698A, graduate standing in the School of Biological Sciences and consent of the graduate adviser; for 698B, Biology 698A or the equivalent.

#### **BIO 398R. Master's Report.**

Preparation of a report to fulfill the requirement for the master's degree under the report option. The equivalent of three lecture hours a week for one semester. Offered on the credit/no credit basis only. Prerequisite: Graduate standing in the School of Biological Sciences and consent of the graduate adviser.

#### **BIO 398T. Supervised Teaching in Biological Sciences.**

Teaching under the close supervision of course instructors; weekly group meetings with the instructor, individual consultations, and reports throughout the teaching period. The equivalent of three lecture hours a week for one semester. Prerequisite: Graduate standing and appointment as a teaching assistant.

#### **BIO 399W, 699W, 999W. Dissertation.**

May be repeated for credit. Offered on the credit/no credit basis only. Prerequisite: Admission to candidacy for the doctoral degree.

### **Professional Courses**