

Biology

Natural Sciences Division

The biology curriculum structures learning based on the scientific process of discovery: observation, interpretation, experimentation, analysis and the formation of new hypotheses. Through exploration of recent developments in the broad range of biological fields, students examine details in the context of basic principles. Students experience the dynamic nature of biological science by participating in laboratory work and research projects that form the backbone of the program. The curricular design offers many choices to students, allowing non-majors to explore any one field of biology in depth or to examine biology in the context of human issues having sociological, economic and political importance, such as health care, biotechnology and the environment.

Introductory and foundation courses are offered at the 100-level. These consist of BIOL 109Y-110Y, the year long introductory lab sequence and BIOL 115 and 116, Energy and Information in Living Systems.

Upper-level courses are offered at the 200 and 300 levels. Courses at the 200 level are designed for sophomores and juniors who have completed at least part of the introductory-level curriculum. Reading assignments include textbooks, primary literature and other advanced sources. Courses at the 300 level are designed for juniors and seniors who have completed the entire introductory-level curriculum and at least one 200 level course. Primary literature and other advanced sources form a substantial portion of the reading, and extensive student-directed work is expected.

In addition to the biology major, major programs in biochemistry and in molecular biology are available. These programs combine work in biology and chemistry to prepare students for graduate work or employment entailing research on the molecular basis of biological systems. Information on course requirements for these major programs is detailed in the biochemistry and molecular biology section.

Non-majors can choose innovative topical courses that approach biological issues in a human context (BIOL 102, 103, 104, 105, 106, 107). These courses are designed for students with minimal backgrounds in biology. The foundation courses — BIOL 115 and 116 — allow more in-depth study. Several courses also serve the interdisciplinary concentration in environmental studies.

For students considering medical, dental, nursing or veterinary postgraduate programs, there is usually a requirement of a minimum of two semesters of biology with the corresponding laboratory work. BIOL 115 and 116 plus the laboratory sequence BIOL 109Y-110Y satisfy this requirement.

Students can involve themselves in the department through the Biology Student Advisory Group, which meets with the chair and faculty members, or as employees ranging from laboratory teaching proctors to research assistants.

Majors are encouraged to participate in the department through research with faculty members and by their active role in hiring faculty, suggesting curriculum changes, inviting seminar speakers and planning social events.

BIOLOGY MAJOR REQUIREMENTS

- BIOL 109Y-110Y, to be completed by end of sophomore year
- BIOL 115 and 116 (or specific exemption by AP or IB), must be completed within the first four semesters
 - Advanced courses may be taken after completion of BIOL 115 and 116 so students can begin advanced courses while completing BIOL 109Y-110Y
- Six upper-division lecture courses, including at least one 300-level course and one 400-level course. MATH 258 and CHEM 256 can each count as one of the six required upper-division courses
- Four upper-division laboratory courses (.5 unit of credit in [BIOL 385, 386] or [BIOL 497, 498] can serve as one .25-unit laboratory course requirement)
- One year of Introductory Chemistry lecture (or equivalent)

In order to fulfill the diversification requirements for upper-level courses, biology majors will need to take at least one upper-level lecture course in each of the following three categories to graduate:

- Environmental biology: BIOL 228, 241, 251, 253, 261, 328, 352 and 362
- Organismal biology/physiology: BIOL 233, 238, 243, 245, 336 and 358
- Cellular and molecular biology: BIOL 238, 255, 263, 266, 315, 321, 333, 375 and CHEM 256

We strongly encourage majors to take at least one year of mathematics and physics. Students planning graduate studies in any area of biology should also include organic chemistry. We encourage majors to seek opportunities for independent research with faculty members, through Research in Biology (BIOL 385, 386) honors research and the Summer Science Scholars Program.

THE SENIOR EXERCISE

The Senior Exercise for all biology majors consists of a detailed analysis of a research field, focusing on a critique of a particular research article. In addition, all majors must attend a specified number of guest lectures in the Biology Seminar Series and take a standardized assessment exam.

ADVANCED COURSES

Many courses and labs are offered in alternating years, so care should be taken in planning the major to suit individual goals. The following list indicates which courses are normally taught on alternating-year schedules. Please note that the schedule can vary from these guidelines; students should consult the department chair or course instructor if particular courses are needed.

Courses that may be offered in alternating years include: BIOL 233, 234, 241, 245, 246, 251, 255, 256, 266, 315, 321, 322, 328, 333, 336, 346, 349, 352, 353, 358, 359, 362 and 375.

HONORS

The Honors Program in biology is an exciting opportunity for students to perform research in collaboration with a faculty member of the Department of Biology. Prior to enrollment in senior honors, students are expected to complete at least one semester of Research in Biology (BIOL 385, 386), although two semesters are recommended, and participate in the Summer Science Scholars Program. Students must have an overall GPA of at least 3.33 and a GPA of 3.33 in biology.

REQUIREMENTS FOR THE BIOLOGY MINOR

- A minimum of 2.75 credits earned in the major curriculum, plus the following:
 - BIOL 109Y-110Y
 - BIOL 115 and 116
 - At least one upper-level lab
 - One year of BIOL 385, 386 would satisfy the upper-level laboratory requirement, and one year of Individual Study (BIOL 393, 394) would satisfy one upper-level lecture course requirement in the minor.

TRANSFER CREDIT POLICY

All transfer credit to be counted for the biology major must be approved in advance by the department chair.

CROSS-LISTED COURSES

The following courses are cross-listed in the biology department to satisfy natural-sciences diversification:

- ENVS 112 Introduction to Environmental Studies
- MATH 258 Mathematical Biology

Courses

BIOL 102 HIV/AIDS IN GLOBAL CONTEXT

Credit: 0.5

Instructor: Edwards

BIOL 103 BIOLOGY IN SCIENCE FICTION

Credit: 0.5 QR

Science-fiction literature extends our knowledge of the natural world in extraordinary ways. Yet real biology is often more amazing than science fiction. The impact of evolution on human existence is examined through Wells's *The Time Machine* and Vonnegut's *Galapagos*, while bizarre living creatures are explored through Herbert's *Dune* and Crichton's *Jurassic Park*. Quantitative reasoning in biology is introduced through problem sets applying calculation to extrapolate present and future biological phenomena. Exponential functions are used to explore whether human populations will explode, as in *Star Trek*, "The Trouble with Tribbles," or decline as in *The Time Machine*. Hardy-Weinberg equilibria and computer modeling show how bizarre mutant traits spread through populations, as in *Galapagos*. Acid-base titrations show how global warming acidifies the ocean, disrupting the marine ecosystem as in Slonczewski's *A Door into Ocean*. Students create their own interactive ecosystems on the Web. May be offered in alternating years. No prerequisites. Does not count toward the major or minor.

BIOL 104 BIOLOGY OF FEMALE SEXUALITY

Credit: 0.5

This is an introductory biology course that considers contemporary health issues of the human female body. In order to better position these issues in the Western patient-medical-pharmaceutical context, we explore the Western feminist critique of science and medicine. Sexual and reproductive biology of the human female is examined as physicians/scientists and women have come to describe and understand it, along with the societal values that influence the research on women. Topics may include the biological bases for understanding cancer, heart disease, reproduction and cloning, contraception, drugs and fetal development, designer drugs and performance, the place for gynecologists and midwives in women's birthing, aging, Eastern medical philosophy, herbal medicines, and better health-care systems. Attention is paid to voices of marginalized women, including black women, lesbians, and disabled women, throughout the course. Students will undertake group projects designed to learn from one another, and groups will learn to lead class discussions using a cooperative learning model. The underlying goals of the course are to improve our capacity to act as

health-care consumers, to forge a feminist understanding of women's health concerns in a social context, and to learn skills for bridging differences amongst our diverse selves. Texts have included Ethel Sloane's *Biology of Women*, Evelyn White's *The Black Women's Health Book*, and *A New View of Woman's Body*. May be offered in alternating years. No prerequisites.

BIOL 105 BIOLOGY OF EXERCISE

Credit: 0.5

This is an introductory biology class that will examine human physiology by considering the response of the human body to exercise. We will ask basic questions about human exercise performance and seek to understand the biological mechanisms that are relevant to these questions. Questions that may be considered include: What limits human exercise performance? How does nutrition influence exercise? What are the mechanisms involved in increased performance during training? How does exercise influence the overall health of humans? Students will learn to directly evaluate the scientific basis of knowledge about physiology through the analysis of experimental methodology and data. No prerequisites. Does not count toward the major or minor. Enrollment limited.

Instructor: C. Gillen

BIOL 106 CONSERVATION BIOLOGY

Credit: 0.5

Instructor: Bickford

BIOL 107 SCALING IN BIOLOGY: WHY SIZE MATTERS

Credit: 0.5 QR

Instructor: Kerkhoff

BIOL 109Y INTRODUCTION TO EXPERIMENTAL BIOLOGY

Credit: 0.25 QR

This is the first laboratory course a student takes and is a prerequisite for all upper-division laboratory courses. Students are introduced to the processes of investigative biology and scientific writing. It is not designed to accompany any particular core lecture course. Laboratories cover topics presented in each of the core lecture courses, BIOL 112, 113, and 114, and introduce a variety of techniques and topics, including field sampling, microscopy, PCR, gel electrophoresis, enzyme biochemistry, toxicology, physiology, evolution, and population biology. The course emphasizes the development of inquiry skills through active involvement in experimental design, data collection, statistical analysis, integration of results with information reported in the literature, and writing in a format appropriate for publication. The year culminates in five-week student-designed investigations that reinforce the research skills developed during the year. Evaluation is based on short reports, quizzes, lab performance, and two scientific papers, as well as oral and written presentations based on the independent project. There are no prerequisites. Enrollment is limited to fourteen students in each of five sections.

BIOL 110Y INTRODUCTION TO EXPERIMENTAL BIOLOGY

Credit: 0.25 QR

See course description for BIOL 109Y.

BIOL 115 ENERGY IN LIVING SYSTEMS

Credit: 0.5

BIOL 116 INFORMATION IN LIVING SYSTEMS

Credit: 0.5

BIOL 211 HEALTH SERVICE AND BIOMEDICAL ANALYSIS

Credit: 0.5

BIOL 228 ECOLOGY

Credit: 0.5

This course will study mechanisms that influence the distribution and abundance of organisms. Topics will include physiological ecology, population ecology, competition, predator-prey systems, mutualism, succession, energy and nutrient dynamics, and the ecology of communities, ecosystems, and landscapes. We will explore the influence of humans on natural systems. Students will use simulation models and original literature to supplement text, lectures, and discussions. Prerequisite: BIOL 112 or permission of instructor. BIOL 229 is highly recommended.

BIOL 229 ECOLOGY LABORATORY

Credit: 0.25

This course examines techniques for studying ecological principles in the field and laboratory, with primary emphasis on terrestrial systems. Students will learn experimental design, sampling protocols, and quantitative methods including spatial analysis with GIS. Topics include limits to distribution, interactions with the physical environment, population dynamics, species interactions, productivity, and biodiversity. Studies will include field trips to local habitats in varying weather conditions. Prerequisite: BIOL 110 and BIOL 112 or permission of the instructor.

BIOL 233 PLANT BIOLOGY

Credit: 0.5

This course presents an introductory examination of plant function and structure. Physiology, morphology, reproduction, and development will be considered, with an emphasis on flowering plants. Comparative life cycles and structures of different divisions of plants and algae will also be discussed, as will problems with plant classification schemes. Emphasis will be placed upon current topics in plant biology, particularly as they relate to important scientific questions and

practical outcomes. May be offered in alternating years. Prerequisite: BIOL 113 or 114 or permission of instructor.

BIOL 234 LABORATORY EXPERIENCE IN PLANT BIOLOGY

Credit: 0.25

This course introduces methods of analyzing plant morphology, histology, physiology, and molecular taxonomy. Topics will include the cell, tissue, and organ structure of vascular seed plants, as well as experimental investigation of selected plant processes such as flowering and hormonal interactions in growth and development. In addition, students will carry out a semester-long independent analysis of an unknown plant. May be offered in alternating years. Prerequisite: BIOL 109Y-110Y. Prerequisite or co-requisite: BIOL 233.

Instructor: Edwards

BIOL 238 MICROBIOLOGY

Credit: 0.5

Microbes inhabit the most extreme environments on earth, ranging from superheated sulfur vents on the ocean floor to alkaline soda lakes. In medicine, newly discovered bacteria and viruses cause a surprising range of diseases, including heart disease; they may even hold the key to human aging. Yet other species live symbiotically with us, keeping us healthy; still others, such as nitrogen fixers, are essential to the entire biosphere. This course covers microbial cell structure and metabolism, genetics, nutrition, microbial communities in ecosystems, and the role of microbes in human health and disease. May be offered in alternating years. Prerequisite: BIOL 113 or BIOL 114.

Instructor: Slonczewski

BIOL 239 EXPERIMENTAL MICROBIOLOGY

Credit: 0.25

We learn the classic techniques of studying bacteria, protists, and viruses in medical science and in ecology. Contemporary high-throughput methods of analysis are performed, such as use of the microplate UV-VIS spectrophotometer. We practice microbial culture and examine life cycles, cell structure and metabolism, and genetics. For the final project, each student surveys the microbial community of a particular habitat, using DNA analysis and biochemical methods to identify microbial isolates. May be offered in alternating years. Prerequisite: BIOL 109-110 or a chemistry lab course. Co-requisite: BIOL 238.

Instructor: Slonczewski

BIOL 241 EVOLUTION

Credit: 0.5

Evolution is the major unifying theory of biology; the unity of fundamental processes, species diversity, and adaptive characteristics of organisms are consequences of evolution, and can be fully understood only in this light. Evolutionary processes also have major impacts on humans. This course introduces the processes of evolution, most of which can be examined in contemporary time through experiment, theory, and simulation, and by examining pattern in

nature. The class format will combine lecture and discussion. Topics will include basic Darwinian arguments, modern population genetics, adaptation, speciation, reconstructing phylogenetic history, macroevolution, and the consequences of evolution for conservation and human health. Examples will be drawn from all levels of biology, from molecular to ecological studies. Students will read and discuss original literature, utilize computer simulations, and prepare a final paper and presentation. Prerequisites: BIOL 112 or BIOL 114 or permission of the instructor.

Instructor: Mauck

BIOL 243 ANIMAL PHYSIOLOGY

Credit: 0.5

Animal physiology examines the processes of animal cells, tissues, and organ systems. In this class, we will seek to understand how physiological processes relate to the survival of an animal in its environment. We will use three primary approaches: (1) comparative, contrasting animals that live in different environments; (2) environmental, exploring how animals survive in challenging environments; and (3) structure-function, examining how the anatomy of a system relates to its function. Each of the primary animal organ systems (nerve, muscle, cardiovascular, respiratory, gastrointestinal, renal, and excretory) will be covered in detail. Readings from the primary research literature will be assigned. This course replaces BIOL 341. Prerequisites: BIOL 110 and BIOL 113, or permission of instructor.

BIOL 244 EXPERIMENTAL ANIMAL PHYSIOLOGY

Credit: 0.25

This laboratory class explores the techniques, equipment, and experimental designs common to animal physiology. Topics to be studied may include muscle physiology, cardiac physiology, salt and water balance, metabolism, and exercise physiology. A variety of experimental techniques will be used. Students will participate in experimental design, perform experiments, and present results in oral and written form. Students will also read and analyze relevant papers from the primary literature. This course replaces BIOL 342. Prerequisite: BIOL 109-110. Prerequisite or co-requisite: BIOL 243 (or BIOL 341).

Instructor: C. Gillen

BIOL 245 ENVIRONMENTAL PLANT PHYSIOLOGY

Credit: 0.5

Plants, like all life forms, survive in community with a diversity of organisms and in a changing and demanding environment. Plant life benefits from and is challenged by relationships with other species and by the environment. Because plants have evolved a fundamentally different pattern of living from those of other kingdoms, the physiological strategies that have evolved to meet the challenges of a predominantly stationary life that relies on resources of the immediate environment are marvelous, intriguing, and enlightening. Our focus is on flowering plants and the structural and physiological processes (molecular, cellular, and systemic) that manage the intersections with the environment and with other organisms. The subject is presented through

examination of experimental design and data analysis. May be offered in alternating years.

Prerequisites: BIOL 113 or BIOL 114; CHEM 111-112.

Instructor: Bickford

BIOL 246 ENVIRONMENTAL PLANT PHYSIOLOGY LAB

Credit: 0.25

Instructor: Bickford

BIOL 251 MARINE BIOLOGY

Credit: 0.5

This course applies ecological principles to the field of marine biology. Topics are organized to explore the diversity of marine habitats. We will study the basics of oceanography that create diverse conditions for marine organisms, the special adaptive pressures on organisms, and the ecological influences on biological diversity. Topics will include chemical properties of seawater, ocean currents, tides, animal and plant communities in the oceans and estuaries, the importance of the sea to humans (through fisheries and influences on global climate), and the problems of pollution in marine ecosystems. May be offered in alternating years. Prerequisite: BIOL 112.

BIOL 253 PALEOBIOLOGY

Credit: 0.5

In this laboratory course, students will employ methods used in the study of marine and freshwater organisms. It is designed to complement either BIOL 251 or BIOL 352. Students will learn to identify freshwater organisms, quantify biological, chemical, and physical parameters that affect these organisms, and design ecological experiments. Throughout the course, laboratories will emphasize hypothesis testing, quantitative methods, and experimental design. Field trips will be taken to local natural habitats, and several lab periods will be spent doing fieldwork. Not offered in most years. Prerequisites: BIOL 109Y-110Y. Prerequisite or co-requisite: BIOL 251 or 352 or permission of instructor.

BIOL 255 GENETIC ANALYSIS

Credit: 0.5

This course introduces both principles and experimental approaches related to heredity in a wide variety of organisms from bacteria to humans. Topics will include classical transmission genetics, chromosomal structure, extranuclear heredity, epigenetics, population and evolutionary genetics, and molecular analysis of genes and chromosomes. As genetic analysis can be used to dissect many biological processes, we will also address how geneticists approach problems and advance scientific understanding, focusing our discussions around primary literature. May be offered in alternating years. Prerequisite: BIOL114.

Instructor: Hicks

BIOL 256 EXPERIMENTAL GENETIC ANALYSIS

Credit: 0.25

This laboratory course introduces both genetic concepts and genetic approaches commonly used to understand biological processes. We will cover fundamental techniques including mutant screens, double mutant analysis, linkage mapping, and map-based cloning of genetic loci. We will use the model plant *Arabidopsis thaliana* as our experimental organism, although the approaches taken in this course can be used in any organism amenable to genetic analysis. May be offered in alternating years. Prerequisite: BIOL 114 and BIOL 109-110Y.

Instructor: Hicks

BIOL 261 ANIMAL BEHAVIOR

Credit: 0.5

The evolution and ecology of animal behavior is explored in detail. The diversity of behavior and the ecological consequences of behavior will be studied, with emphasis on how research programs are designed to answer questions. Topics include the genetics and physiology of behavior, perceptual systems, integration and storage of information, the ecology of reproduction, feeding behavior, habitat selection and migration, and social behavior.

Prerequisite: BIOL 112.

Instructor: Mauck

BIOL 262 EXPERIMENTAL ANIMAL BEHAVIOR

Credit: 0.25

This laboratory applies the principles of experimental design and inference to the study of animal behavior. There will be both laboratory and field components. Students should be aware that animals do not always "behave" in discrete, three-hour time periods, and that some work may have to be arranged outside of the regularly assigned class period. Prerequisites: BIOL 109Y-110Y and permission of the instructor. Prerequisite or co-requisite: BIOL 261.

Instructor: Mauck

BIOL 263 MOLECULAR BIOLOGY AND GENOMICS

Credit: 0.5

The molecular and genomic basis of life is at the heart of modern biology. In BIOL 263, we will learn techniques and explore research questions at the forefront of molecular research, focusing on the mechanisms by which the information of the genome is expressed to form the functional molecules of living cells and organisms. The processes of DNA replication, recombination and repair, transcription of RNA from DNA templates, and translation of RNA into protein are discussed in the context of current research, frequently using primary literature. The function of genes and regulation and measurement of gene expression are treated in depth. Students analyze and publish interactive tutorials on the structure and function of key macromolecules. This intermediate-level course presumes a strong background in the basics of protein structure/function, central dogma processes, fundamental molecular techniques for manipulating nucleic acids and proteins, and general chemistry. Prerequisites: BIOL 113, 114 and one year of chemistry (Intro or Honors Intro). Recommended prerequisite or co-requisite: CHEM

231 and 232 (Organic Chemistry). Note: For further study of the function of proteins, membranes, and cellular processes, the complementary course BIOL 366 (Cell Physiology) is recommended.

BIOL 264 GENE MANIPULATION

Credit: 0.25

This course teaches advanced methods of gene isolation, manipulation, and characterization. An assortment of the following techniques will be covered: the isolation of DNA and RNA from tissues and cells; recombinant DNA technique; expression of genes in heterologous systems; the polymerase chain reaction (PCR); measurement of gene expression, and bioinformatics and sequence analysis. Prerequisite: BIOL 109Y-110Y. Prerequisite or corequisite: BIOL 263, one year of chemistry with labs, or permission of instructor.

BIOL 266 CELL BIOLOGY

Credit: 0.5

Instructor: Itagaki

BIOL 267 EXPERIMENTAL CELL BIOLOGY

Credit: 0.25

Instructor: Itagaki

BIOL 311 SEMINAR IN RESTORATION ECOLOGY

Credit: 0.5

BIOL 315 CELL SIGNALING

Credit: 0.5

Instructor: K. Gillen

BIOL 321 EVOLUTIONARY DEVELOPMENTAL BIOLOGY

Credit: 0.5

This course concerns the mechanisms responsible for building multicellular eukaryotic organisms, with examples from vertebrates, invertebrates, and plants. The processes of fertilization, embryonic axis formation, morphogenesis, organogenesis, and cellular differentiation will be examined at the molecular and cellular levels. Particular attention will be devoted to the experimental basis for current models of these processes. Students will read original research literature as well as standard texts. May be offered in alternating years.

Prerequisites: BIOL 114 and any 200-level BIOL course.

BIOL 322 EXPERIMENTS IN DEVELOPMENTAL BIOLOGY

Credit: 0.25

This laboratory course introduces students to both classical and modern experimental approaches for discovering developmental mechanisms, using model systems including sea urchin, chick, *Xenopus*, *Drosophila*, *Caenorhabditis*, and zebrafish. Students document major cellular and developmental events in embryogenesis of these organisms, and conduct

experiments to investigate the cellular, molecular, and genetic bases of morphogenesis, pattern development, and developmental determination. May be offered in alternating years.

Prerequisites: BIOL 114 and BIOL 109Y-110Y . Prerequisite or co-requisite: BIOL 321.

Instructor: Hicks

BIOL 323 PHOTOSYNTHESIS

Credit: 0.5

BIOL 328 GLOBAL ECOLOGY AND BIOGEOGRAPHY

Credit: 0.5

This is a comprehensive course in the large-scale history and dynamics of the biosphere. The course will begin with a focus on biogeography and macroecology, with the goal of describing and understanding very general patterns in the distribution, abundance, and functioning of organisms. Special attention will be given to patterns of biodiversity and their basis in both ecological (dispersal, competition) and evolutionary (speciation, extinction) processes. The second phase of the course will examine current attempts to model dynamic ecological processes at the global scale, with a focus on feedbacks between ecosystems and the atmosphere, and the relationship between biodiversity and ecosystem function. The conclusion of the course will examine the large-scale interactions between Homo sapiens and the rest of the biosphere, including recent attempts to quantify both human impacts and the value of global ecosystem services. The course will be conducted seminar-style, and most of the reading will be drawn from recent primary literature. The development of research methods using published data, Internet databases, and model output to address ecological questions at continental to global scales will be an integral part of this course. May be offered in alternating years. Prerequisites: At least one of BIOL 228, 241, 251, or 261, or permission of the instructor.

Instructor: Kerkhoff

BIOL 333 ENVIRONMENTAL TOXICOLOGY

Credit: 0.5

This course examines the effects of chemical contaminants on molecular, organismal, and ecological systems. Topics include sources and movement of contaminants in the environment, basics of toxicity testing, mechanisms of contaminant effects, and ecological risk assessment. The course will use readings from standard texts, the popular press, and primary literature, placing particular emphasis on current experimental approaches and problem solving methods. Rather than surveying a wide variety of topics superficially, the course will concentrate on selected issues and stories that illustrate important contemporary issues in environmental toxicology. May be offered in alternating years. Prerequisite: Biol 113 or Biol 114 or permission of instructor.

Instructor: Powell

BIOL 336 INTEGRATIVE BIOLOGY OF ANIMALS

Credit: 0.5

This course will seek to understand general principles in animal biology through a topics-based approach. We will develop integrative understandings of animals, studying them from genetic,

molecular, biochemical, physiological, organismal, evolutionary, and environmental frameworks. Although both invertebrate and vertebrate animals will be studied, invertebrates will be the primary focus because of the large number and spectacular diversity of invertebrate species. Emphasis will be placed upon understanding the experimental evidence that has led to the current understanding of animal biology, and controversial topics in animal biology will be explored. May be offered in alternating years. Prerequisite: At least one biology lecture course at the 200 or 300 level.

Instructor: C. Gillen

BIOL 346 INTRODUCTION TO MICROSCOPY AND IMAGE ANALYSIS

Credit: 0.25

This laboratory is designed to give students theoretical background in and an opportunity to use the power of microscopy as an investigative tool. To accomplish this, we will be investigating questions pertaining to the physiology of plants and fungi. Techniques covered will include: bright, dark-field, phase-contrast, and differential interference microscopy (DIC); and the preparation and viewing of living cells and tissues. Confocal, digital deconvolution, and electron microscopy will also be covered. May be offered in alternating years. Prerequisite: BIOL 109Y-110Y.

Instructor: Edwards

BIOL 352 AQUATIC SYSTEMS BIOLOGY

Credit: 0.5

This course is designed to introduce students to the study of freshwater ecosystems, including lakes, streams, and wetlands. Human activities have had profound impacts on freshwater life. An understanding of the dynamics of freshwater systems is instrumental in determining how to protect and restore these habitats. We will examine the physical, chemical, and biological factors influencing biological diversity and productivity, and will emphasize the application of ecological principles to the study of these systems. Possible topics include the effects of agricultural run-off and eutrophication; erosion resulting from human development; the introduction of non-native species; toxic contaminants; and restoration techniques. Standard texts as well as primary literature will be used. May be offered in alternating years. Prerequisite: BIOL 112 or permission of the instructor.

Instructor: Fennessy

BIOL 353 AQUATIC SYSTEMS LAB

Credit: 0.25

In this laboratory course, students will employ methods used in the study of freshwater organisms. It is designed to complement either BIOL 251 or BIOL 352. Students will learn to identify freshwater organisms, quantify biological, chemical, and physical parameters that affect these organisms, and design ecological experiments. Throughout the course, laboratories will emphasize hypothesis testing, quantitative methods, and experimental design. Field trips will be taken to local natural habitats, and many lab periods will be spent doing fieldwork. May be

offered in alternating years. Prerequisites: BIOL 109Y-110Y. Prerequisite or corequisite: BIOL 251 or 352 or permission of instructor.

Instructor: Fennessy

BIOL 358 NEUROBIOLOGY

Credit: 0.5

The study of the nervous system is a field that has experienced explosive growth in the past few decades. This course is designed to introduce the student to modern neurobiology by covering the basic foundations as well as the latest results from current research. Subject matter will range from the biophysics of membranes and ion channels, through sensory integration and simple behaviors, to the development of the nervous system. Rather than cover a wide variety of topics superficially, we will concentrate more time on selected topics that illustrate the current thinking of neurobiologists. May be offered in alternating years. Prerequisites: BIOL 113 and 114.

Experience in math and/or physics is strongly recommended.

Instructor: Itagaki

BIOL 359 EXPERIMENTAL NEUROBIOLOGY

Credit: 0.25

This is a laboratory designed to complement the lecture course. We will concentrate on the different intracellular and extracellular electrophysiological recording techniques commonly used in the field to illustrate both motor and sensory aspects of nervous-system function. We will also use molecular techniques to define the distribution of some neurotransmitters in the central nervous system. We will conclude with a series of independent projects that will bring together the ideas covered earlier in the course. May be offered in alternating years. Prerequisites: BIOL 109Y-110Y or BIOL 109Y-111Y. Prerequisite or co-requisite: BIOL 358.

Instructor: Itagaki

BIOL 362 ECOLOGICAL AND EVOLUTIONARY PHYSIOLOGY

Credit: 0.5

Students will read the current primary literature in the fields of physiological ecology and evolution while learning to use the modern tools integral to the discipline. The seminar combines student-led discussion with hands-on activities in both field and lab. In discussion modules, students will read and critique important papers ranging from life history evolution to techniques for assessing age-related changes on the cellular level. Research modules apply both field and laboratory techniques presented in the readings. Individual research projects will involve the student in experimental design, field sample collection, laboratory molecular techniques, appropriate statistical analysis, and oral presentation of the data. Not offered in most years. Pre-requisites: Permission of the instructor and completion of the introductory biology series.

Instructor: Mauck

BIOL 375 VIROLOGY

Credit: 0.5

Instructor: Slonczewski

BIOL 385 RESEARCH IN BIOLOGY

Credit: 0.25

This combined discussion and laboratory course aims to develop abilities for asking sound research questions, designing reasonable scientific approaches to answer such questions, and performing experiments to test both the design and the question. We consider how to assess difficulties and limitations in experimental strategies due to design, equipment, organism selected, and so on. The course provides a detailed understanding of selected modern research equipment. Students select their own research problems in consultation with one or more biology faculty members. This course is designed both for those who plan to undertake honors research in their senior year and for those who are not doing honors but want some practical research experience. A student can begin the course in either semester. If a year of credit is earned, it may be applied toward one laboratory requirement for the major in biology.

Prerequisites: BIOL 112, 113, 114, 109Y-110Y, and permission of instructor.

BIOL 386 RESEARCH IN BIOLOGY

Credit: 0.25

This combined discussion and laboratory course aims to develop abilities for asking sound research questions, designing reasonable scientific approaches to answer such questions, and performing experiments to test both the design and the question. We consider how to assess difficulties and limitations in experimental strategies due to design, equipment, organism selected, and so on. The course provides a detailed understanding of selected modern research equipment. Students select their own research problems in consultation with one or more biology faculty members. This course is designed both for those who plan to undertake honors research in their senior year and for those who are not doing honors but want some practical research experience. A student can begin the course in either semester. If a year of credit is earned, it may be applied toward one laboratory requirement for the major in biology.

Prerequisites: BIOL 112, 113, 114, 109Y-110Y, and permission of instructor.

BIOL 393 INDIVIDUAL STUDY IN BIOLOGY

Credit: 0.25-0.5

This course provides the student with the opportunity to pursue an independent investigation of a topic of special interest not covered, or not covered in depth, in the current curriculum. The investigation, designed in consultation with the chosen faculty mentor, may be designed to earn .25 or .5 unit of credit in a semester and may be continued in BIOL 394 in the second semester. BIOL 393 and 394 are ordinarily library-oriented investigations. (For laboratory-oriented independent research, see BIOL 385 and 386.) Normally, students receive credit for no more than two semesters of independent study. Independent study does not count toward diversification requirements for the biology major. Prerequisite: permission of the department.

BIOL 475 SENIOR SEMINAR

Credit: 0.5

BIOL 493 INDIVIDUAL STUDY IN BIOLOGY

Credit: 0.25-0.5

This course provides the student with the opportunity to pursue an independent investigation of a topic of special interest not covered, or not covered in depth, in the current curriculum. The investigation, designed in consultation with the chosen faculty mentor, may be designed to earn .25 or .5 unit of credit in a semester and may be continued in BIOL 394 in the second semester. BIOL 393 and 394 are ordinarily library-oriented investigations. (For laboratory-oriented independent research, see BIOL 385 and 386.) Normally, students receive credit for no more than two semesters of independent study. Independent study does not count toward diversification requirements for the biology major. Prerequisite: permission of the department.

BIOL 497 SENIOR HONORS

Credit: 0.5

This course offers an in-depth research experience. Prior to enrollment in Senior Honors, students are expected to complete at least one semester of BIOL 385-386 (Research in Biology) and participate in the Summer Science Scholar program. Two semesters of BIOL 385-586 are recommended. Emphasis is on completion of the research project. Students are also instructed in poster production and produce one or more posters of their honors work for presentation at Kenyon and possibly at outside meetings. There will be oral progress reports. The letter grade is determined by the instructor and project advisor in consultation with the department. Students must have an overall GPA of at least 3.33 and a GPA of 3.33 in biology. Prerequisites: Permission of the project advisor and the department.

BIOL 498 SENIOR HONORS

Credit: 0.5

This course continues the honors research project and gives attention to scientific writing and the mechanics of producing a dissertation. A dissertation is required and is defended orally to an outside examiner. The letter grade is determined by the instructor and project advisor in consultation with the department. Prerequisites: BIOL 385 or 386, and 497.