Biology

NATURAL SCIENCES DIVISION

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The biology curriculum structures learning based on the scientific process of discovery: observation, interpretation, experimentation, analysis, and the formation of new theory. Through exploration of recent developments in the broad range of biological fields, students examine details in the context of basic principles. They 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 nonmajors 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.

For new students who are considering biology courses, a number of options are available. Look for the ◆ symbol, which designates those courses particularly appropriate for first-year students or upperclass students new to the biology curriculum.

Biology majors must take all foundation courses: BIOL 112, 113, 114 (unless specifically exempted by AP exams or by the departmental placement exams during orientation), and the year-long introductory laboratory sequence, BIOL 109Y-110Y or BIOL 109Y-111Y. The foundation courses may be taken in any sequence desired, but they must be completed within a span of the first four semesters. Advanced courses may be taken after completion of the prerequisite foundation course, so students can begin advanced courses while completing the introductory series. A year of introductory chemistry is also required of students, beginning with the class of 2007.

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 in some of the most exciting 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. For additional information, see the chair of either the biology or chemistry department.

Nonmajors can choose innovative topical courses that approach biological issues in a human context (BIOL 102, 103, 104, 105). These courses are designed for students with minimal backgrounds in biology. The "foundation" courses—BIOL 112, 113, and 114—allow more in-depth study. Nonmajors with special interests can take one foundation course followed by an allied advanced course—for example, BIOL 112 with BIOL 228 (Ecology); BIOL 113 with BIOL 238 (Microbiology); BIOL 114 with BIOL 255 (Genetic Analysis). Ecology courses also serve the interdisciplinary Environmental Studies Concentration.

Minor concentrations are available in biology or in one of these areas: general biology, environmental

biology, plant biology, molecular biology and genetics, and physiology. The requirements for these minors are detailed below.

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 113 and 114 plus the laboratory sequence BIOL 109-110 or BIOL 109-111 satisfy this requirement.

Requirements for the Biology Major

The following requirements apply to students who declare a major in biology.

- BIOL 112, 113, 114 (or specific exemption) to be completed within four semesters of starting this series.
- BIOL 109 and 110 or BIOL 109 and 111 to be completed by the end of the sophomore year.
- Five upper-division lecture courses.*
- Four upper-division laboratory courses* (1/2 unit of credit earned in Research in Biology, Research Strategies, or Senior Honors can serve as one 1/4-unit laboratory course requirement).

* Beginning with the Class of 2006, 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, 261, 272, and 352.
- Organismal biology/physiology: BIOL 233, 236, 238, 245, 341, and 358.
- Cellular and molecular biology: BIOL 238, 239, 255, 263, 321, 333, and 366.
- Beginning with the Class of 2007, we will require 1 year of Introductory Chemistry lecture (CHEM 113-114, 115-116, or AP placement)

We strongly encourage majors to take **at least** one year of chemistry, 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, honors research, and the Summer Science Scholarships.

The Senior Exercise for all biology majors consists of a library research paper or multimedia project addressing a current research question in biology. In addition, all majors must attend a specified number of guest lectures in the Biology Seminar Series.

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.

Advanced Courses Offered in Biology

Many courses and laboratories are offered in alternate years, so care should be taken in planning the major to suit individual goals.

Courses offered in 2004-05 include: BIOL 228, 229, 233, 234, 238, 239, 241, 245, 261, 262, 263, 264, 333, 353, 358, 359, and 386.

Courses that probably will be offered in 2005-06 include: BIOL 228, 229, 233, 234, 236, 237, 251, 255, 256, 261, 262, 263, 272, 321, 322, 341, 342, 346, and 367.

Requirements for the Biology Minor

The minor in biology can be earned in one of five areas of biology, listed as A through E below. The minor requires a minimum of 3 units of credit earned in the major curriculum; these must include the introductory laboratories, BIOL 109 and BIOL 110 or 111, and at least one upper-level laboratory. One year of BIOL 385, 386 would satisfy the upper-level laboratory requirement and one year of BIOL 393, 394 would satisfy one upper-level lecture course requirement in any of the area minors. Specific course requirements for each area minor are listed below.

ATTENTION: Please be advised that the two 1-unit requirements below must include at least one upper-level laboratory. The 2 units mean 2 units of earned credit, not 4 courses per se.

A. Environmental Biology

BIOL 109-110 or BIOL 109-111 Introduction to Experimental Biology
BIOL 112 Evolution and Ecology

2 units from:
BIOL 228 Ecology
BIOL 229 Ecology Laboratory
BIOL 241 Evolution
BIOL 251 Marine Biology
BIOL 261 Animal Behavior
BIOL 262 Experimental Animal Behavior
BIOL 272 Microbial Ecology
BIOL 352 Aquatic Systems Biology
BIOL 353 Aquatic Systems Lab
ENVS 461 Environmental Studies

B. Plant Biology

BIOL 109-110 or BIOL 109-111 Introduction to Experimental Biology
BIOL 112 Evolution and Ecology
BIOL 113 From Cell to Organism

1 1/2 units from:
BIOL 233 Plant Biology
BIOL 234 Laboratory Experiences in Plant Biology
BIOL 245 Plant Physiology
BIOL 346 Introduction to Microscopy and Image Analysis

C. Molecular Biology and Genetics
BIOL 109-110 or BIOL 109-111 Introduction to Experimental Biology
BIOL 114 Genetics and Development of Organisms

2 units from:
BIOL 238 Microbiology
BIOL 239 Microbiology Laboratory
BIOL 255 Genetic Analysis
BIOL 256 Experimental Genetic Analysis
BIOL 263 Molecular Biology
BIOL 321 Developmental Biology
BIOL 322 Experiments in Developmental Biology
BIOL 364 Principles of Gene Manipulation

D. Physiology
BIOL 109-110 or BIOL 109-111 Introduction to Experimental Biology
BIOL 113 From Cell to Organism

2 units from:
BIOL 236 Animal Biology
BIOL 237 Experimental Animal Biology
BIOL 238 Microbiology
BIOL 239 Microbiology Laboratory
BIOL 245 Plant Physiology
BIOL 333 Environmental Toxicology
BIOL 341 Comparative Animal Physiology
BIOL 342 Experimental Animal Physiology
BIOL 346 Introduction to Microscopy and Image Analysis
BIOL 358 Neurobiology
BIOL 359 Experimental Neurobiology
BIOL 366 Cell Physiology
BIOL 367 Experimental Cell Physiology

E. Biology
BIOL 109-110 or BIOL 109-111 Introduction to Experimental Biology
BIOL 112 Evolution and Ecology
BIOL 113 From Cell to Organism
BIOL 114 Genetics and Development of Organisms

1 unit:
Any upper-level courses in biology

Cross-Listed Courses

The following course is cross-listed in the biology offerings for 2004-05:

ENVS 112 Introduction to Environmental Studies

First-Semester Courses

Introduction to Experimental Biology
◆ QR BIOL 109 (1/4 unit)
P. Heithaus, Staff

This is the first laboratory course a student takes in the two-semester introductory sequence and is a prerequisite for all upper-division laboratory courses. The decision to take BIOL 109-110 as opposed to BIOL 109-111 depends on a student's academic goals. BIOL 109-110 is taken by students who are interested in focusing on anatomy and physiology during the second semester, and BIOL 109-111 is taken by students whose primary interest is molecular biology.

BIOL 109 introduces students to the processes of investigative biology and scientific writing in journal format. 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 including field sampling, microscopy, enzyme biochemistry, bacterial transformation, and gel electrophoresis. The course emphasizes experimental design, data collection, statistical analysis, the integration of results with information reported in the literature, and the effective communication of conclusions. Evaluation is based on short lab assignments and two scientific papers. A laboratory manual must be purchased. There are no prerequisites. Enrollment is limited to fourteen students in each of five sections.

Evolution and Ecology
◆ BIOL 112 (1/2 unit)
Fennessy, Mauck

This course examines the principles of ecology, evolution, the environments of our biosphere, and the effects of human activities on ecosystems. We will examine the processes that generate and maintain biological diversity. Topics will include evolutionary theory, methods for interpreting earth's biota, terrestrial and aquatic habitats, analyses of interactions among organisms as well as between organisms and their environments, models of ecosystems, and the conflicts between human population growth and conservation of the environment. Grades are based on two tests, weekly quizzes, and a final exam. The text is also used for BIOL 113 and 114. No prerequisites. Majors and nonmajors may enroll.

From Cell to Organism
◆ BIOL 113 (1/2 unit)
Edwards, K. Gillen

The focus is on the structure and function of cells and multicellular tissues. A biochemical approach is used through most of the topics, which include molecular and sub-cellular organization of prokaryotic and eukaryotic cells, transport and energy management, and the structure of tissues in plants and animals. The course is designed to introduce the student to the process of scientific thinking as well as to the principles of cellular biology. Some research methodology and approaches to unanswered questions are examined. Evaluation is based on assignments, attendance, class participation, and exams. The text is also used for BIOL 112 and 114. This course is offered both semesters. Students who are comfortable with their high-school biology will find this course an appropriate challenge as a first course in biology. Those who are less comfortable may find BIOL 112 more amenable as a first course in biology. No prerequisites. Majors and nonmajors may enroll.

Genetics and Development of Organisms
BIOL 114 (1/2 unit)
Powell

This course introduces the mechanisms of heredity, the expression of genetic information, and the means by which genes encode developmental programs. Genetics and development are part of a continuous process, and the genetic mechanisms and developmental patterns of living organisms reveal a fundamental kinship of life on earth. Genetics and molecular biology as tools for the study of biological problems will be introduced, as will current topics in biotechnology. The text is also used for BIOL 112 and BIOL 113. Prerequisite: BIOL 112 or BIOL 113, or sophomore standing. Majors and nonmajors may enroll.

Plant Biology
BIOL 233 (1/2 unit)
Hicks

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. Prerequisite: BIOL 113 or 114 or permission of instructor. Enrollment limited.

Laboratory Experience in Plant Biology
BIOL 234 (1/4 unit)
Hicks

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, and 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. Prerequisite: BIOL 109-110 or BIOL 109-11. Prerequisite or co-requisite: BIOL 233. Enrollment limited.

Evolution
BIOL 241 (1/2 unit)
R. Heithaus

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.

Animal Behavior
BIOL 261 (1/2 unit)
Mauck

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.

Experimental Animal Behavior
BIOL 262 (1/4 unit)
Mauck

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 109-110 or BIOL 109-111 and permission of the instructor. Prerequisite or co-requisite: BIOL 261. Enrollment limited.

Molecular Biology and Genomics
BIOL 263 (1/2 unit)
Slonczewski

This course focuses on molecular genetics, 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. The function of genes and regulation of gene expression is treated in depth. Students analyze and publish interactive tutorials on the structure and function of key macromolecules. For further study of the function of proteins and membranes, the complementary course BIOL 366 (Cell Physiology) is recommended. Prerequisites: BIOL 113, 114; one year of chemistry; or permission of the instructor.

Gene Manipulation
BIOL 264 (1/4 unit)
Powell

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; Southern and Northern blotting; isolation of specific DNA clones; subcloning DNA fragments into plasmid vectors; characterization of DNA clones by restriction mapping;

expression of eukaryotic genes in bacterial hosts; the polymerase chain reaction (PCR); and bioinformatics and sequence analysis. Prerequisite: BIOL 109-110 or BIOL 109-111. Prerequisite or co-requisite: BIOL 363, CHEM 113, 114, or permission of instructor. Enrollment limited.

Aquatic Systems Laboratory
BIOL 353 (1/4 unit)
Fennessy

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. Prerequisites: BIOL 109-110 or BIOL 109-111. Prerequisite or co-requisite: BIOL 251 or 352 or permission of instructor. Enrollment limited.

Cell Physiology
BIOL 366 (1/2 unit)
Itagaki

This course is designed to introduce the student to the wide variety of questions being asked by researchers in this exciting field and the approaches they are taking to anser these questions. This course complements BIOL 363 (Molecular Biology) in content, concentrating on the nongenomic aspects of cell function. We will cover topics such as biological membranes and ion channels, cell organelles and their function, cell regulation, and intercellular and intracellular communication. Prerequisite: BIOL 113 and BIOL 114. Prerequisite or co-requisite: CHEM 111-112.

Research in Biology
BIOL 385 (1/4 unit)
Edwards

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, 109-110 (or 109-111), and permission of instructor.

Special Topic: Genomic and Proteomic Data Analysis
BIOL 391 (1/2 credit)
Radmacher

This course introduces students to the analysis of large-scale biological data sets resulting from genomic and proteomic techniques. Emphasis will be on interdisciplinary collaboration; students with a background in the biological sciences will be encouraged to work with students with a backgrtound in the analytical sciences. First, DNA microarrays will be discussed: what are they, what type of data do they produce, and what research questions can they be used to address. Students will then explore various statistical and computational techniques for analyzing microarray data. The same approach will be repeated for proteomic techniques, including 2D protein gels. Within interdisciplinary groups, students will be responsible for reading and interpreting research articles from the primary scientific literature, implementing statistical/computational analysis techniques on genomic and proteomic data sets, interpreting the results of their analyses, and presenting their results to the class. Prerequisites: BIOL 113 and 114 or MATH 206 or MATH 218 and permission of instructor.

Independent Study in Biology
BIOL 393/493 (1/4 or 1/2 unit)
Staff

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 1/4 or 1/2 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.

Senior Honors
BIOL 497 (1/2 unit)
Slonczewski

This course offers an in-depth research experience. Prior to enrollment in Senior Honors, students are expected to complete at least one semester of Research in Biology (BIOL 385, 386) and participate in the Summer Science Scholar Program. Two semesters of Research in Biology 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 3.2 and a GPA of 3.33 in biology. Prerequisites: BIOL 385 and/or 386, and permission of the department.

Second-Semester Courses

Women's Health
◆ BIOL 104 (1/2 unit)
Edwards

This is an introductory biology course that considers contemporary issues in Western women's health using a feminist, multidisciplinary and multiethnic/multicultural approach. The 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, the place for gynecologists and midwives in women's birthing, and issues of health insurance and community-based primary care and prevention. Attention is paid to voices of marginalized women, including black women, lesbians, and disabled women, throughout the course. Active student participation and learning from one another as well as team learning is strongly fostered. Students will undertake group projects designed so that they 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 may include Ethel Sloane's *Biology of Women*, Evelyn White's *The Black Women's Health Book*, and *A New View of Woman's Body*. No prerequisites. Enrollment limited.

Introduction to Experimental Biology
◆ QR BIOL 110 (1/4 unit)
P. Heithaus, Staff

BIOL 110 follows BIOL 109. This course focuses on the relationship between structure and function using the cat as a model system, explores animal physiology using a variety of vertebrate and invertebrate organisms, and culminates in five-week student-designed independent projects that reinforce the inquiry techniques developed in BIOL 109. Evaluation is based on a practical examination and an oral presentation (for anatomy), short reports (physiology), and an oral presentation and a scientific paper (independent research project). Prerequisite: BIOL 109. Enrollment is limited to fourteen students in each of four sections.

Introduction to Experimental Molecular Biology
◆ BIOL 111 (1/4 unit)
Hicks

BIOL 111 follows BIOL 109 and is an alternative to BIOL 110. The course first focuses on experimental questions in genetics and molecular biology. It culminates in five-week student-designed independent projects, as does BIOL 110. Evaluation is based on short reports, laboratory papers, oral presentation of the independent research project, and the research paper. Prerequisite: BIOL 109. Enrollment is limited.

Introduction to Environmental Studies
◆ ENVS 112 (1/2 unit)
R. Heithaus

This interdisciplinary course examines contemporary environmental problems, introducing the major concepts pertaining to human interactions with the environment. We will explore both local and global scales of this interaction. Course topics include basic principles of ecology, the impacts of human technology, roots of our perceptions and reactions to nature, the social and legal framework for responding to problems, and economic issues surrounding environmental issues. We will discuss methods for answering questions regarding the consequences of our actions and especially focus on methods for organizing information to evaluate complex issues. The format of the course will be three-quarters discussion and lecture, one-quarter "workshop." The workshops will include field trips and experience with collecting and analyzing data. This course is cross-listed with the Environmental Studies Concentration and does not count toward the biology major or minor.

From Cell to Organism
◆ BIOL 113 (1/2 unit)
K. Gillen

See first-semester course description.

Genetics and Development of Organisms
BIOL 114 (1/2 unit)
Hicks, Powell

See first-semester course description.

Ecology
BIOL 228 (1/2 unit)
Fennessy

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.

Ecology Laboratory
BIOL 229 (1/4 unit)
R. Heithaus

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. Prerequisites for this course are BIOL 110 and BIOL 112 or permission of the instructor. Enrollment limited.

Microbiology
BIOL 238 (1/2 unit)
Slonczewski

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. Prerequisite: BIOL 113 or BIOL 114. Co-requisite: BIOL 239. Enrollment limited.

Experimental Microbiology
BIOL 239 (1/4 unit)
Slonczewski

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, including use of the microplate UV-VIS spectrophotometer and 2-D gel electrophoresis. We practice microbial culture and examine life cycles, cell structure and metabolic pathways, and isolation of organisms from the field. For the final project, each student separates and identifies a pair of potential human pathogens, combining classic dichotomous analysis with quantitative digital technologies. Prerequisite: BIOL 109-110 or BIOL 109-111 or a chemistry lab course. Co-requisite: BIOL 238. Enrollment limited.

Environmental Plant Physiology
BIOL 245 (1/2 unit)
Edwards

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

Gene Manipulation
BIOL 264 (1/4 unit)
Powell

See first-semester course description.

Environmental Toxicology
BIOL 333 (1/2 unit)
Powell

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. Prerequisite: Biol 113 or Biol 114 or permission of instructor.

Neurobiology
BIOL 358 (1/2 unit)
Itagaki

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. Prerequisites: BIOL 113, 114. Experience in math and/or physics is strongly recommended. **Note:** Students requiring BIOL 358 for the Neuroscience Program may substitute BIOL 341 (Comparative Animal Physiology).

Experimental Neurobiology
BIOL 359 (1/4 unit)
Itagaki

This is a laboratory designed to complement the lecture course. We will concentrate mostly on the different electrophysiological techniques that have been crucial to the development of this field. We will use both extracellular and intracellular recording techniques on preparations that will illustrate various aspects of membrane function, ion channels, synaptic physiology, and sensory coding. Computer simulations will be used to illustrate some crucial techniques. Prerequisites: BIOL 109-110 or BIOL 109-111. Prerequisite or co-requisite: BIOL 358. Enrollment limited.

Research in Biology
BIOL 386 (1/4 unit)
Fennessy

See first-semester description of BIOL 385.

Independent Study in Biology
BIOL 394/494 (1/4 or 1/2 unit)
Staff

See first-semester description of BIOL 393/493.

Senior Honors
BIOL 498 (1/2 unit)
R. Heithaus

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.

The following courses will likely be taught in 2005-06:

HIV and Infectious Disease
◆ BIOL 102 (1/2 unit)
Edwards

This course introduces students to the biology of the Human Immunodeficiency Viruses (HIVs) and other microbial pathogens that are potential large-scale risks to the human population. Treatment of the basic biology of the immune system will be followed by consideration of virus life cycles at the molecular level and the pathology of AIDS. The emergence of deadly viruses into the human population will be studied in the context of the evolution of virulence. The social, economic, and political ramifications of infectious disease will be considered. This course does not count toward the major or minor. Enrollment limited. No prerequisites.

Biology in Science Fiction
◆ BIOL 103 (1/2 unit)
Slonczewski

Science-fiction literature extends our knowledge of the natural world in extraordinary ways. Yet real biology is often more amazing than science fiction. This course explores bizarre biology in fact and fiction, from Herbert's *Dune* and Crichton's *Jurassic Park* to the bottom of the Marianas Trench. The impact of biology on human existence is examined through Wells's *The Time Machine* and Vonnegut's *Galapagos*. Quantitative reasoning in biology is introduced through *Star Trek*'s "The Trouble with Tribbles." To learn scientific methods of investigation, we follow Scully and Mulder's pursuit of the deadly human fluke. Students use digital technology to interpret data and investigate the mysterious appearance of alien life forms. Visiting professors from neighboring planets present guest lectures on their native ecosystems. No prerequisites. Does not count toward the major or minor. Enrollment limited.

Biology of Exercise
◆ BIOL 105 (1/2 unit)
C. Gillen

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.

Animal Biology
BIOL 236 (1/2 unit)
C. Gillen

This course will seek to understand general principles in animal biology. We will attempt to develop cross-disciplinary understandings of animals, studying them from genetic, molecular, biochemical, physiological, organismal, and environmental approaches. To explore the diversity of animal life, we will study how anatomical forms relate to specific functions and how these functions relate to animals' ability to survive in specific habitats. 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. Prerequisite: BIOL 112, 113, or 114.

Experimental Animal Biology
BIOL 237 (1/4 unit)
C. Gillen

This laboratory class will explore the comparative structure and function of animals. We will explore comparative anatomy, animal diversity, evolutionary relationships, and function of living animals. Laboratory work will be complemented with critical reading of recent research papers and consideration of controversies in animal biology. Prerequisites: BIOL 109-110 or BIOL 109-111; BIOL 112,113, or 114. Note: The lecture course BIOL 236 is not a prerequisite for this course. Enrollment limited.

Marine Biology
BIOL 251 (1/2 unit)
R. Heithaus

This course applies ecological principles to the field of marine biology. Topics include chemical properties of seawater, ocean currents, waves, 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. Prerequisite: BIOL 112.

Genetic Analysis
BIOL 255 (1/2 unit)
Staff

Human genetics is the focus of Genetic Analysis. Recent discoveries in mammalian cloning, whole genome sequencing, and embryonic stem cell culture promise extraordinary medical advances and societal dilemmas. In agriculture, the genetic manipulation of plants and plant pathogens is transforming our economy. Yet the unforseen genetic results of our progress, such as the rise of drug-resistant bacteria, threaten our future. We cover the fundamental techniques

of molecular analysis that led to these discoveries, as well as the basics of population genetics and mechanisms of evolution. Recent research papers are analyzed. We conclude with speculative discussion of future genetic advances based on readings of science-fiction texts. Prerequisite: BIOL 112 or BIOL 114. Enrollment limited.

Experimental Genetic Analysis
BIOL 256 (1/4 unit)
Hicks

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. Prerequisite: BIOL 114 and either BIOL 109-110 or BIOL 109-111. Enrollment limited.

Microbial Ecology
BIOL 272 (1/2 unit)
Slonczewski

Microbes form the foundation of our terrestrial biosphere and perhaps that of other planets as well. Most conversions of the nitrogen cycle are performed exclusively by microbes; much of the global carbon and oxygen cycle depends on them. Yet less than 0.01 percent of the microbial species detectable in our environment are known to science. This course investigates the essential roles of microbes in various ecosystems, ranging from deep-sea thermal vent communities, to Ohio wetlands, to the human digestive flora. We examine microbial mutualism in systems such as the luminescent organs of deep-sea fish, the fungal germination of orchids, and the digestion of wood by termites. The diversity of microbial flora is explored, including protists, fungi, algae, prokaryotes, and archaea. We practice methods of identification and enumeration of environmental microbes. Applications of these topics include bioremediation and water treatment. Prerequisite: BIOL 112 or 113, or permission of the instructor.

Developmental Biology
BIOL 321 (1/2 unit)
Hicks

This course concerns the mechanisms responsible for building multicellular organisms. The processes of fertilization, embryogenesis, post-embryonic development, and aging 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. Prerequisites: BIOL 113 and 114.

Experiments in Developmental Biology
BIOL 322 (1/4 unit)
Hicks

This laboratory course introduces students to modern approaches for discovering developmental mechanisms, using model systems such as *Drosophila*, *Xenopus*, *Caenorhabditis*, zebrafish, and *Arabidopsis*. 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. Particular attention is paid to gene expression that is responsible for morphogenesis, pattern formation, and developmental determination. Prerequisites: BIOL 114 and BIOL 109-110 or BIOL 109-111. Prerequisite or co-requisite: BIOL 321. Enrollment limited.

Comparative Animal Physiology
BIOL 341 (1/2 unit)
C. Gillen

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 the physiologies of 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. Prerequisites: BIOL 110 or BIOL 111, and BIOL 113, or permission of instructor.

Experimental Animal Physiology
BIOL 342 (1/4 unit)
C. Gillen

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 different 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. Prerequisite: BIOL 109-110 or BIOL 109-111. Prerequisite or co-requisite: BIOL 341. Enrollment limited.

Introduction to Microscopy and Image Analysis
BIOL 346 (1/4 unit)
Edwards

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. Prerequisite: BIOL 109-110 and BIOL 109-111. Enrollment limited.

Experimental Cell Physiology
BIOL 367 (1/4 unit)
Itagaki

This laboratory course is designed to complement BIOL 366. The topics covered in the laboratory will expose the student to some of the standard techniques used in modern cell biology. The laboratories will also illustrate some of the fundamental ideas of the field. Instead of covering a wide variety of techniques and preparations superficially, we will concentrate on a select few, covering them in greater depth. Some topics that will be covered are protein and lipid separation, cell permeability, cell motility, and mitochondrial function. Prerequisites: BIOL 109-110 or BIOL 109-111. Prerequisite or co-requisite: BIOL 366. Enrollment limited.