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.

New Students

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.

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. 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 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. 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 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 263 (Molecular Biology and Genomics). 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 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 109-110 to be completed by the end of the sophomore year.

- Five upper-division lecture courses.*
- Four upper-division laboratory courses* (.5 unit of credit earned in Research in Biology, Research Strategies, or Senior Honors can serve as one .25-unit laboratory course requirement).

* 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, 261, 272, and 352.
- Organismal biology/physiology: BIOL 233, 238, 243, 245, and 358.
- Cellular and molecular biology: BIOL 238, 255, 263, 321, 333, and 366.
- Beginning with the Class of 2007, we will require one year of Introductory Chemistry lecture (CHEM 121-124, 122-125, 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.

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.

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 2006-07 include: BIOL 228, 229, 233, 234, 238, 239, 241, 243, 244, 261, 262, 263, 264, 352, 353, 366, 367, 385, and 386.

Courses that may be offerd in 2007-08 include: BIOL 228, 229, 241, 243, 244, 251, 255, 256, 261, 262, 263, 264, 321, 322, 336, 346, 358, 359, 385, and 386.

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) and participate in the Summer Science Scholar Program. Two semesters of research in biology are recommended. Students must have an overall GPA of at least 3.33 and a GPA of 3.33 in biology.

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 109-110, 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 four courses per se.

A. Environmental Biology
BIOL 109-110 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 Introduction to Experimental Biology
BIOL 112 Evolution and Ecology
BIOL 113 From Cell to Organism

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

C. Molecular Biology and Genetics
BIOL 109-110 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 and Genomics
BIOL 264 Gene Manipulation
BIOL 321 Developmental Biology
BIOL 322 Experiments in Developmental Biology
BIOL 364 Principles of Gene Manipulation

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

2 units from:
BIOL 238 Microbiology
BIOL 239 Microbiology Laboratory
BIOL 243 Comparative Animal Physiology
BIOL 244 Experimental Animal Physiology
BIOL 245 Environmental Plant Physiology
BIOL 333 Environmental Toxicology
BIOL 336 Integrative Biology of Animals
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 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 Course

The following course is cross-listed in the biology offerings for 2006-07:

ENVS 112 Introduction to Environmental Studies

Year Courses

Introduction to Experimental Biology

QR BIOL 109Y-110Y (.5 unit)
P. Heithaus, Staff

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.

First-Semester Courses

Biology in Science Fiction

◆ **QR** BIOL 103 (.5 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. 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. No prerequisites. Does not count toward the major or minor. Enrollment limited.

Evolution and Ecology

◆ BIOL 112 (.5 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 three tests, weekly quizzes, and a final exam. The text is also used for BIOL 113 and 114. No prerequisites. Majors and nonmajors may enroll. Biology majors should take this class prior to Junior year.

From Cell to Organism

◆ BIOL 113 (.5 unit)
Itagaki, staff

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-cel-

lular 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 (.5 unit)
Slonczewski

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.

Evolution

BIOL 241 (.5 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.

Comparative Animal Physiology

BIOL 243 (.5 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 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 or 111 and BIOL 113, or permission of instructor.

Experimental Animal Physiology

BIOL 244 (.25 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 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). Enrollment limited.

Animal Behavior

BIOL 261 (.5 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 (.25 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 (.5 unit)
Powell

This course focuses on molecular genetics, the mechanisms by which the information of the genome is expressed to form the functional mol-

ecules 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 (.25 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; 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 263, CHEM 113, 114, or permission of instructor. Enrollment limited.

Global Ecology and Biogeography

BIOL 328 (.5 unit)
Kerkhoff

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. Prerequisites: At least one of BIOL 228, 241, 251, or 261, or permission of the instructor.

Aquatic Systems Biology

BIO 352 (.5 unit)
Fennessy

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. Prerequisite: BIOL 112 or permission of the instructor.

Aquatic Systems Laboratory

BIOL 353 (.25 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 109Y-110Y or BIOL 109Y-111Y. Prerequisite or co-requisite: BIOL 251 or 352 or permission of instructor. Enrollment limited.

Research in Biology

BIOL 385 (.25 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.

Independent Study in Biology

BIOL 393/493 (.25 or .5 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 .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.

Senior Honors

BIOL 497 (.5 unit)
Itagaki

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

Introduction to Environmental Studies

◆ ENVS 112 (.5 unit)
R. Heithaus, Mauck

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 (.5 unit)
C. Gillen

See first-semester course description.

Genetics and Development of Organisms

BIOL 114 (.5 unit)
Powell, staff

See first-semester course description.

Ecology

BIOL 228 (.5 unit)
Kerkhoff

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 (.25 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.

Plant Biology

BIOL 233 (.5 unit)
Edwards

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 (.25 unit)
Edwards

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. Prerequisite: BIOL 109Y-110Y or BIOL 109Y-111Y. Prerequiste or co-requisite: BIOL 233. Enrollment limited.

Microbiology

BIOL 238 (.5 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 (.25 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.

Gene Manipulation

BIOL 264 (.25 unit)
Powell

See first-semester course description of BIOL 264.

Cell Biology

BIOL 366 (.5 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 answer 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.

Experimental Cell Biology

BIOL 367 (.25 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.

Research in Biology

BIOL 386 (.25 unit)
Kerkhoff

See first-semester description of BIOL 385.

Special Topic: Seminar in Physiological Ecology and Evolution: Telomere Dynamics and Individual Quality

BIOL 392 (.5 unit)
Haussmann, Mauck

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. Pre-requisites: Permission of the instructor and completion of the introductory biology series.

Independent Study in Biology

BIOL 394/494 (.25 or .5 unit)
Staff

See first-semester description of BIOL 393/493.

Senior Honors

BIOL 498 (.5 unit)
Fennessy

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 may be offered in 2007-08:

Women's Health

◆ BIOL 104 (.5 unit)
Edwards

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*. No prerequisites. Enrollment limited.

Biology of Exercise

◆ BIOL 105 (.5 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.

Environmental Plant Physiology

BIOL 245 (.5 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.

Marine Biology

BIOL 251 (.5 unit)
R. Heithaus

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. Prerequisite: BIOL 112.

Genetic Analysis

BIOL 255 (.5 unit)
Hicks

Heredity is one of the most fundamental phenomena of living organisms. In addition, quantitative analysis of inheritance patterns provides a powerful tool for dissection of biological functions. This course will focus both on the basic principles of genetics and on the application of genetic techniques to the understanding of biological processes. Topics we may discuss include transmission genetics, the chromosome theory of inheritance, classical and molecular strategies for gene mapping, chromosome structure, DNA replication and repair, gene expression and the regulation of gene activity, strategies for identifying and isolating genes, quantitative and population genetics, and the genetics of bacteria and viruses. Prerequisite: BIOL 114.

Experimental Genetic Analysis

BIOL 256 (.25 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 BIOL 109-110 or BIOL 109-111. Enrollment limited.

Developmental Biology

BIOL 321 (.5 unit)
Hicks

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

Experiments in Developmental Biology

BIOL 322 (.25 unit)
Hicks

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. Prerequisites: BIOL 114 and BIOL 109-110 or BIOL 109-111. Prerequisite or co-requisite: BIOL 321. Enrollment limited.

Integrative Biology of Animals

BIOL 336 (.5 unit)
C. *Gillen*

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. This course replaces BIOL 236 Animal Biology. Prerequisite: At least one biology lecture course at the 200 or 300 level.

Introduction to Microscopy and Image Analysis

BIOL 346 (.25 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.

Neurobiology

BIOL 358 (.5 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 (.25 unit)
Itagaki

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 some immunocytochemistry and histochemical techniques to define the distribution of some neurotransmitters in the central nervous system. The course will conclude with a series of independent projects that will bring together the ideas covered earlier in the course. Prerequisites: BIOL 109-110 or BIOL 109-111. Prerequisite or co-requisite: BIOL 358. Enrollment limited.