

Biology

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<i>Chair, Spring 2020:</i> Timothy H. Parker Susanne M. Altermann Michael Coronado Elizabeth Danka Heidi E. M. Dobson	Kate Jackson Leena S. Knight Thomas A. Knight Britney L. Moss (on Sabbatical, Spring 2020)	Christopher S. Wallace Ginger S. Withers

Biology courses deal with the science of living organisms in their various forms. The curriculum emphasizes the integration of all levels from molecular to ecological, with evolution as a unifying theme, and requires all seniors to complete a research thesis. The department serves students who expect to work in a biological field or related profession such as medicine, as well as those who elect biology as part of a general education (see www.whitman.edu/biology).

A student who enters Whitman without any prior college-level preparation in biology will have to complete 50 credits, including courses in chemistry, mathematics and statistics, and biology, to fulfill the requirements for the biology major.

Distribution: Courses completed in biology apply to the science and quantitative analysis (selected courses) distribution areas.

Total credits required to complete a Biology major: A student who enters Whitman College with no prior experience in Biology will need to complete a total of 50 credits (33 credits in Biology and/or BBMB; 11 credits in Chemistry; 6 credits in Mathematics and Statistics).

Learning Goals: Upon graduation,

- **Students will understand core biological concepts including:**
 - evolution (the process creating the diversity of life-forms and the phylogenetic relationships among major groups)
 - structure and function (the basic units of biological structures that control the functions of living things)
 - information flow, exchange and storage (the influence of genetics on the control of the development of phenotypes)
 - pathways and transformations of energy and matter (the ways in which chemical transformation pathways and the laws of thermodynamics govern biological systems)
 - the nature of complex systems.
- **Students will be capable of understanding, interpreting, and critically evaluating scientific information presented in multiple forms (e.g., numeric, graphical, written)**
- **Students will be capable of conducting a structured scientific inquiry and thoroughly communicating scientific biological knowledge**

The Biology major: A minimum of 33 credits in biology, including Biology 111, 112, 205, 206; four credits from each of the three categories of upper-level courses (Molecular/Cell Biology, Organismal Biology, Ecology/Evolution); 489; 490 or 498; 499; and additional courses in biology and/or BBMB courses numbered 200 or above to earn a minimum total of 33 credits in biology and/or BBMB. Chemistry 125, 126, 135, 136, or 140; 245; and demonstrated mastery of either two semesters of college calculus (Mathematics 125 and 126) or one semester each of college calculus and statistics (Mathematics 128 or 247, Economics 227, Psychology 210, Sociology 208) is required. Departmental policy does not allow a P-D-F grade option for biology or BBMB courses that count toward the major.

The senior assessment consists of oral and written components: a one-hour oral exam administered by a committee of biology faculty, and students must take the biology Major Field Test (MFT) and score in the 70th percentile or above.

The department recommends that students considering a major in biology consult with an adviser and begin with Chemistry 125, 126, 135, 136; or 140; Mathematics 125 and 126 or statistics; and Biology 111 or 112. For those planning to pursue most graduate programs in biology, a year of physics (with labs), a full year in organic chemistry, a year of foreign language, as well as statistics and competency with computers are highly recommended.

Honors in the major: In biology and biology combined majors, students do not apply for admission to candidacy for honors. Students whose thesis earns a grade of at least A-, who pass the Senior Comprehensive Examinations with distinction, and who attain a Cumulative GPA of 3.3 and a major GPA of 3.5, may be granted Honors in Major Study by the biology department faculty. The biology department chair will notify the Registrar of those students attaining Honors in Major Study not later than the beginning of the third week of April for spring honors thesis candidates. An acceptable digital copy of the Honors Thesis must be submitted to Penrose Library no later than Reading Day.

The Biology minor: Biology 111, 112, and a minimum of eight additional credits in biology and/or BBMB courses numbered 200 or above. Departmental policy does not allow a P-D-F grade option for biology courses that count toward the minor.

The Biology-Geology combined major: Biology 111, 112, 205; four credits each from the Organismal Biology and Ecology/Evolution categories, and at least four additional credits in biology and/or BBMB courses numbered 200 or above; Geology 110 and 111; 120 and 121, or 125 and 126; Geology 227, 270, 350, 470; Geology 312 or 268; Geology 301, 321, or 405; and a minimum of one credit in 358; either three credits of Geology 480, 490, or 498 or three credits of Biology 489, 490, or 498; Chemistry 125, 126, 135, 136 or Chemistry 140; 245; Mathematics 125, 126 or statistics (Mathematics 128 or 247, Economics 227, Psychology 210, Sociology 208). Two semesters of physics and field experience are strongly recommended.

The Biochemistry, Biophysics, and Molecular Biology (BBMB) major: See BBMB under the *Courses and Programs* section in the catalog for a description of the courses and major offered at the interface of biology, chemistry, and physics.

The Biology-Environmental Studies combined major: The requirements are fully described in the *Environmental Studies* section of the catalog.

Upper-Level Course Categories

Molecular/Cell Biology: Biology 303 *Cell Biology*, 304 *Cell Biology Laboratory*, 305 *Cellular Physiology and Signaling*, 306 *Cellular Physiology and Signaling Lab*, 319 *Developmental Biology Seminar*, 320 *Neurobiology*, 329 *Developmental Biology*, 331 *Synthetic Cell Biology*, 339 *Microbiology and Immunology*, 342 *Gene Discovery & Functional Genomics*, BBMB 325 *Biochemistry*, 326 *Molecular Biology*, 335 *Biochemistry Laboratory*, 336 *Molecular Biology Laboratory*, and 337 *Techniques in Biochemistry and Biophysics*.

Organismal Biology: Biology 253 *Plant Physiology*, Biology 310 *Physiology*, 315 *Comparative Vertebrate Anatomy*, 323 *Neurophysiology*, 328 *Evolutionary Developmental Biology*, 330 *Pathophysiology*, 338 *Evolutionary Developmental Biology Lab*, 351 *Exercise Physiology*.

Ecology/Evolution: Biology 212 *Natural History of the Inland Northwest*, 215 *Plant Ecology*, 218 *Symbiosis*, 220 *Grassland Ecology Lab*, 225 *Ornithology Lab*, 229 *Plant Identification Lab*, 277 *Ecology*, 287 *Ecology Lab*, 288 *Plants and Peoples*, 316 *Transformations in Vertebrate Evolution*, 327 *Biology of Amphibians and Reptiles*, 337 *Biology of Amphibians and Reptiles Lab*, and 350 *Evolutionary Biology*.

Some Special Topics courses may be applied to the above categories. Any Special Topics courses applied to the above will be noted in the course descriptions.

110 Evolution for Everyone

Not offered 2019-20

4 credits

Evolution is a word that seems to attract curiosity and controversy wherever it goes. In this non-majors biology class we will talk about what evolution is and isn't, and how evolutionary theory can be used or misused in a variety of social and scientific contexts. Topics will include evolutionary responses of organisms to climate change; the evolution of our food; and how principles of evolution inform epidemiology and medicine. In the accompanying lab, students will develop and test basic evolutionary hypotheses using model organisms as well as computer simulations, and will learn and practice fundamentals of scientific writing. Three lecture/discussion hours and one three-hour lab per week. *Lab fee:* maximum \$30.

111 Biological Principles

Fall, Spring **Fall: L. Knight and T. Knight; Spring: Wallace and Withers**

4 credits

The general principles common to all life. Topics are: chemical basis of life and cellular metabolism, cell and tissue structure and function, mitosis and meiosis, information storage and retrieval, and life support mechanisms. Although designed as an introduction to the major, nonmajor students are welcome. Laboratories will consist of exercises illustrating the principles covered in lecture. Three hours of lecture and one three-hour laboratory per

week. *Prerequisites:* Chemistry 125 and 135; or 140. *Pre- or corequisites:* Chemistry 126 and 136 (unless Chemistry 140 previously completed). *Lab fee:* maximum \$30.

112 The Biological World

Fall, Spring

H. Dobson and K. Jackson

4 credits

A survey of the major groups of prokaryotic and eukaryotic organisms. The evolutionary history of living organisms is traced from the most simple prokaryotes to the highly complex plants and animals. Parallel trends and adaptations are discussed in addition to the unique features of each group. Laboratories consist of the examination of the structure and characteristics of the major groups. It is recommended that students take Biology 111 or an equivalent course prior to this course. Three lectures and one three-hour laboratory per week. *Lab fee:* maximum \$30.

113 Environmental Toxicology

Not offered 2019-20

2 credits

Students will be introduced to the concept of toxicology and how it relates to the environment and residing organisms. The course will be split into two components. The first half will focus on the principles of toxicology including exposure, biotransformation, kinetics, dynamics and specific toxicological topics. Specific topics including genetic, neuro, cardiovascular and reproductive toxicology, which will be examined alongside scientific literature and real-life exposure scenarios. The second half of the course will focus on how the environment and residing organisms respond to harmful exposures. We will discuss the concepts of chemical fate, bioaccumulation and the effects exposures have on shaping the ecosystem. The course will conclude with an overview of how communities and governments shape policy to avoid extreme exposure scenarios and the consequences of when these policies fail. Coursework will include short-lectures by the instructor, along with discussion of the scientific literature and case studies assigned for each lecture topic. In addition, students will have the opportunity to pick their favorite toxin or toxicant and explore how this object affects organismal physiology and the surrounding ecosystem. One 120-minute lecture/discussion per week.

114 Tree Biology

Fall

Altermann

3 credits

The trees among us seem familiar companions, but their internal functioning and external ecological roles are not. This course is a survey of the natural history, ecology, physiology, and evolution of large woody plants. Students will learn how to identify trees, how they function, and their ecological importance in and out of the context of climate change. Designed for non-Biology majors. Performance will be evaluated based on exams and class assignments. The course includes a field trip to the Blue Mountains.

115 Natural History and Ecology

Spring

Parker

4 credits

This course emphasizes applying basic ecological and evolutionary principles to inferring processes responsible for biological patterns students observe in the field. The core of the class is weekly trips in the region between the Columbia River and the Blue Mountains. On these trips students gain familiarity with common plants and animals of the region as part of the process of developing and applying skills observing biological patterns. Students learn to interpret these patterns in light of biological concepts learned in class. Two one-hour lectures and one five-hour field trip per week. Designed for nonscience majors with special applicability for environmental studies majors. Field trips begin at 11 a.m. and extend through the lunch hour and into the afternoon. Offered in alternate years.

118 Agroecology

Not offered 2019-20

4 credits

From garden plots to industrial agriculture, we will investigate how ecological principles explain and inform modern food production. Designed for non-biology majors, this course is an introduction to community ecology, ecosystem ecology, botany, and genetics as they relate to the practice of all agriculture, but with an emphasis on sustainable agriculture. We will use readings, discussions, field trips, and greenhouse experiments to deepen our understanding of how biotic and abiotic factors constrain and facilitate food production. Designed for non-biology majors. Three

lecture hours and one three-hour laboratory per week. Offered in alternate years. *Lab fee*: maximum \$30.

120 Human Anatomy and Physiology

Not offered 2019-20

4 credits

Designed for the nonbiology major. Lectures will focus on the structures and functions of organ systems responsible for maintenance, reproduction and regulation of the human body, including their evolutionary origins and their major malfunctions such as caused by diseases. Laboratories will parallel the lectures to reinforce processes introduced in lecture, will include students as test subject (e.g., measuring temperature, respiration, electrocardiograms, etc.), and may include dissection of preserved animals. Three lecture or discussion hours and one three-hour laboratory per week. May not be taken for credit by those who have completed Biology 310. *Lab fee*: maximum \$30.

121 History and Ethnobiology of the Silk Roads

Not offered 2019-20

2 credits

This interdisciplinary and interdivisional course will provide an integrative exploration into the history and ethnobiology of peoples along various branches of the trading routes across Asia known as the silk roads, with an emphasis on China prior to 1400. Topics will include why certain goods and technologies were traded; agricultural, social, and religious impacts of trading; biological features of items traded or moved along the silk roads, such as foods, beverages, fibers, animals, and diseases. See Asian and Middle Eastern Studies 221 for an optional, supplemental field course that will be offered when funding permits. *Corequisite*: History 121.

122 Plant Biology

Not offered 2019-20

2 credits

This course provides a basic introduction to the biology of plants, and is designed for non-biology majors. It examines plant structure, physiology, reproduction, and ecology, including evolutionary adaptations to different environments. Two lectures per week. *Optional corequisite*: Biology 129.

125 Genes and Genetic Engineering

Not offered 2019-20

2 credits

Designed for non-science majors. An introduction to principles of genetics related to medicine, agriculture and biotechnology. The class will focus on selected genetics-related topics of current social, environmental or economic importance, and will include student-led investigations into benefits and controversies of those topics and related applications.

127 Nutrition

Not offered 2019-20

3 credits

The required nutrients and their food sources, their metabolism, and eventual functions and fates in the body will be discussed. Principles applied to specific life stages and circumstances. Current topics in nutrition will be addressed, including eating disorders, global nutrition issues, world hunger, food additives, supplements, pesticide use, factors leading to chronic disease, etc. Students will read current articles and develop analytical skills, which enable them to make informed decisions regarding food choices. Designed for non-biology majors. Three lectures per week.

129 Plant Identification Lab

Not offered 2019-20

1 credit

In this field-oriented laboratory, students will explore aspects of body form and growth that characterize different plant groups, acquire basic skills for plant identification, and learn to recognize on sight the most common plant families in the western United States. At least one lab will be substituted by a field trip, and all students will be required to make a plant collection. This lab course is designed for non-majors, and meets concurrently with Biology 229. One three-hour laboratory per week. *Corequisite*: Biology 122. *Lab fee*: maximum \$30.

130 Conservation Biology

Not offered 2019-20

4 credits

An introduction to the dynamic and interdisciplinary world of biological conservation. Fundamental principles from genetics, evolution, and ecology will be discussed and then applied to problems including extinction, species preservation, habitat restoration, refuge design and management, and human population growth and its myriad impacts on our environment. Three one-hour lectures and one three-hour laboratory per week. Designed for nonscience majors with special applicability for environmental studies majors. *Lab fee*: maximum \$30.

171, 172 Special Topics in Biology for Nonscience Majors

1-4 credits

Lectures (possibly with laboratories) on topics in biology not generally covered by other nonmajor courses in the department. Examples of topics include field biology and evolution. The topic and course credit will be designated prior to registration for the semester in which a special topic for nonscience majors is offered. Any current offerings follow.

171 ST: Evolution Seminar

Fall

Cooley

2 credits

Evolution is a word that seems to attract curiosity and controversy wherever it goes. In this non-majors' biology seminar we will talk about what evolution is and isn't, and how evolutionary theory can be used or misused in a variety of social and scientific contexts. Topics will include evolutionary responses of organisms to climate change; the evolution of our food; and how principles of evolution inform epidemiology and medicine. This discussion-intensive seminar will be evaluated based on writing assignments, exams, projects, and participation. One 80-minute meeting per week. Distribution area: Science.

172 ST: Microbiota: We're all covered in "bugs!"

Spring

Danka

3 credits

Students will gain an appreciation of the wide-spread nature of microbes, and will learn to love (not fear or hate) the billions of organisms that reside on and within their bodies. We will discuss the bacteria, viruses, fungi, and *Archaea* that inhabit our bodies, talk about how we were first colonized by these organisms, and how the diversity of organisms in an individual's microbiota changes over time. The human microbiota will be connected to the development of our immune systems, prevention of infectious diseases, consumption of microbe-rich foods and drinks, mental health, disease states, and more. Students will learn to read and interpret current primary scientific literature, and will compare journal articles to what is reported in the media. By the end of the course, students will question whether they are really just one organism. The coursework will include short lectures by the professor, case studies, discussions focused on interpreting primary scientific literature, comparisons of primary literature and media reports, and well-known microbe-focused literature. Two 80-minute combination lecture/discussion sections per week. Distribution area: science.

177 Ecology of the American West

Not offered 2019-20

4 credits

This course will explore the adaptations and relationships of organisms to their abiotic and biotic environments, with focus on the varied ecosystems of the Hells Canyon region of northeastern Oregon and the high desert ecosystems of northern New Mexico. Students will come to understand the forces impacting, and the impact of, individual organisms as they exist over time and space, as parts of higher levels of ecological constructs including the population, community, and ecosystem. A significant proportion of the class will be spent in the field quantifying vegetative associations and a selection of the fauna inhabiting those associations. The course is team-taught sequentially over two intensive, two-week periods. Laboratory sessions consist primarily of fauna and flora identification, ecological monitoring techniques including vegetative plot monitoring, dry pitfall monitoring, and avian transect monitoring. Environmental studies majors may substitute this course for Biology 130 or 115, as a

foundation course in the sciences, with a lab, to satisfy environmental studies major requirements. *Prerequisites:* required of, and open only to, students accepted to Semester in the West.

205 Genetics

Fall, Spring **Fall: Cooley; Spring: Hutchison and Vernon** **3 credits**

The principles which underlie the hereditary processes observed in microbes, plants, and animals. Selected topics include structure, organization, function, regulation, and duplication of the genetic material; protein synthesis and its control; mechanisms and patterns of inheritance; population genetics. *Prerequisites:* Biology 111; Chemistry 125 and 126, or Chemistry 140; sophomore status.

206 Genetics Laboratory

Spring **Forsthoefel** **1 credit**

Laboratory exercises in molecular and Mendelian genetics. Labs will include DNA isolation, amplification, and characterization, introductions to computer DNA analysis and genomics, and an extended project in Mendelian genetics, involving phenotypic observation and segregation analysis. One three-hour laboratory per week. Prior completion of Biology 205 is recommended, but not required. Biology 206 is not recommended for BBMB majors. *Pre- or corequisite:* Biology 205. *Lab fee:* maximum \$30.

212 Natural History of the Inland Northwest

Not offered 2019-20 **4 credits**

This course will engage biology majors with the plants, animals, and topography of a specific biotic province of our region (e.g., Blue Mountains or Walla Walla Valley) within the larger context of its geology and paleoecological history. The class will emphasize field experiences and interpretation of ecological and evolutionary processes shaping our surroundings with discussion of current environmental issues facing the area. One three-hour class per week, eight six-hour labs, some overnight. Applies to the Ecology/Evolution major requirement. *Prerequisites:* Biology 112; Biology 215 or 277 recommended (or concurrent). *Lab fee:* maximum \$85.

215 Plant Ecology

Not offered 2019-20 **3 credits**

This course covers the diverse adaptations of plants to their abiotic and biotic environments from ecological and evolutionary perspectives. Lectures will address effects of climatic factors (water, light, temperature) and soils on plant morphology, physiology, growth, and reproduction, and the complex relationships of plants with other forms of life, especially insects. Three hours of lecture per week, plus one field trip during the semester. Applies to the Ecology/Evolution major requirement. Offered in alternate years. *Prerequisites:* Biology 111 and 112.

218 Symbiosis

Spring **Altermann** **4 credits**

From the origin of mitochondria to the phenomenon of zombie ants, intimate interactions between phylogenetically unrelated organisms are ubiquitous and important components of ecological communities. This course is a survey of topics in symbiology including the evolutionary history of the eukaryotic cell, vertical inheritance, acquisition of metabolic pathways, development of novel symbiotic structures, and partnership specificity. The course includes multiple scales of interaction spanning the level of molecules to the level of ecosystems. All major taxonomic groups are represented. The course includes lectures, case studies, and discussions of the primary literature. The laboratory portion of the course includes design and execution of manipulative experiments. Applies to the Ecology/Evolution major requirement. *Prerequisites:* Biology 111 and 112 or consent of instructor. Offered in alternate years. *Lab fee:* maximum \$30.

220 Grassland Ecology Lab

Not offered 2019-20 **1 credit**

Exploration of grassland and shrubland ecosystems based on field trips and research. Research designed to give students experience in the process of ecological science, including observing patterns to develop questions, searching primary literature, evaluating hypotheses and predictions, initiating experiments and gathering data in the

field, processing data, statistical analysis, and presenting results in written and graphical form. Fieldwork will involve various physical demands such as hiking and working off-trail on steep slopes. One three or four hour lab per week. Approximately six times during the semester we will depart at noon rather than 1 pm. One required full-day or overnight field trip. Applies to the Ecology/Evolution major requirement. *Prerequisite:* Biology 112. *Lab fee:* maximum \$30.

221 Human Anatomy and Physiology I
Not offered 2019-20

4 credits

A survey of the structure and function of the human body that will examine cells, tissues, and the skeletal, muscular, endocrine, and the nervous systems. This course will emphasize both structure and function by integrating anatomical knowledge with principles of physiology from the cellular to the organismal level, including clinical relevance. Lab sessions will include animal dissection, participation of students as subjects (e.g., electromyography), and may incorporate lectures or demonstrations by clinicians/patients. Three lectures and one three-hour laboratory per week. Cannot be applied to the Biology major Organismal requirement. *Prerequisite:* Biology 111; or consent of instructor. *Lab fee:* maximum \$30.

222 Human Anatomy and Physiology II
Spring

L. Knight and T. Knight

4 credits

A survey of the structure and function of the human body that will examine cardiovascular, respiratory, digestive, urinary, immune, endocrine, and reproductive systems. This course will emphasize both structure and function by integrating anatomical knowledge with principles of physiology from the cellular to the organismal level, including clinical relevance. Lab sessions will include animal dissection, participation of students as subjects (e.g., respirometry), and may incorporate lectures or demonstrations by clinicians/patients. Three lectures and one three-hour laboratory per week. Cannot be applied to the Biology major Organismal requirement. *Prerequisite:* Biology 111 or consent of instructor. Human Anatomy and Physiology I is not a prerequisite. *Lab fee:* maximum \$30.

225 Ornithology Lab
Spring

Parker

1 credit

An introduction to the study of birds based on field trips, lab activities, and research. Research designed to give students experience in the processes of doing science, including searching primary literature, evaluating hypotheses and predictions, gathering and processing data, statistical analysis, and presenting results in written and graphical form. One three or four hour lab per week. Approximately six times during the semester we will depart at noon rather than 1 pm. One required full-day or overnight field trip. Applies to the Ecology/Evolution major requirement. *Prerequisite:* Biology 112. *Lab fee:* maximum \$30.

229 Plant Identification Lab
Not offered 2019-20

1 credit

In this field-oriented laboratory, students will explore aspects of body form and growth that characterize different plant groups, acquire basic skills for plant identification, and learn to recognize on sight the most common plant families in the western United States. At least one lab will be substituted by a field trip, and all students will be required to make a plant collection. This lab course is designed for biology majors, and meets concurrently with Biology 129. One three-hour laboratory per week. Applies to the Ecology/Evolution major requirement. *Prerequisite:* Biology 112. *Lab fee:* maximum \$30.

253 Plant Physiology
Fall

Altermann

4 credits

Plant physiology is the study of how plants function, internally as well as in relation to their environment. We will investigate how plants use light, water, and minerals to grow and reproduce, at scales ranging from the molecular to the ecological. The course includes both lecture and laboratory components. Applies to the Organismal major requirement. *Prerequisite:* Biology 111. *Lab fee:* maximum \$30.

256 Regional Biology**Not offered 2019-20****1 credit**

Field biology of a region with emphasis on ecology and evolution in a natural history context. Students will keep field notebooks, and their notebook entries must meet minimum standards. Trips will usually be taken over one long weekend (typically Thursday to Sunday). May be repeated for credit for different destinations. This course does not count towards the major requirements in biology or biology combined majors. Graded credit/no credit.

Prerequisites: Biology 111 and 112 and declared biology or biology-environmental studies major or biology minor.
Fee: maximum \$75.

271, 272 Special Topics in Biology**1-4 credits**

Any current offerings follow.

272 ST: Mycology**Spring****4 credits**

This course is a survey of the current understanding of the biology of fungi and their ecology. Course will begin with the evolutionary and human history of fungi, and the fundamentals of fungal cell biology, fungal genetics, genomics, and sex. We'll conduct a broad survey of fungal diversity and current systematics of fungi. We'll use these concepts to explore the classical ecological understandings of fungi, including: fungi as decomposers, pathogens, and mutualists. We'll then explore how these classical understandings are falling apart, by looking at new understandings of fungi as planet-level ecosystem engineers, as citizens of microbiomes, and as players in evolutionary arms races. As part of this we'll re-examine "well-understood" symbioses - lichens, mycorrhizae, and endophytic relationships. Current topics including fungal biotechnology and implications of climate change will be examined. As an applied example, throughout the course we will get to know the coffee rust (*Hemileia vestatrix*). Three lecture/discussion hours and one three-hour lab per week. Applies to the Ecology/Evolution requirement. *Prerequisites:* Biology 111 and Biology 112. *Lab fee:* maximum \$30. Distribution area: science with a lab.

277 Ecology**Fall****Parker****3 credits**

The relationships of organisms to one another and to the abiotic environment. We will learn ecological concepts and principles important to populations, evolution, inter-specific interactions, communities, landscapes, energy flow, nutrient cycles, and conservation. Three lectures per week. Applies to the Ecology/Evolution major requirement.

Prerequisites: Biology 111 and 112.

287 Ecology Lab**Fall****Parker****1 credit**

Field research designed to give students experience in the process of ecological science, including observing patterns to develop questions, searching primary literature, evaluating hypotheses and predictions, initiating experiments and gathering data in the field, processing data, statistical analysis, and presenting results in written and graphical form. Fieldwork will involve various physical demands such as hiking and working off-trail on steep slopes. One three or four hour lab per week. Approximately six times during the semester we will depart at noon rather than 1 pm. Applies to the Ecology/Evolution major requirement. *Prerequisite:* Biology 112. *Lab fee:* maximum \$30.

288 Plants and Peoples**Fall****H. Dobson****3 credits**

The relationship between plants and human societies, drawing examples from different geographical regions and placing emphasis on plants used for food, medicine, clothing, and shelter. Topics will explore the various uses of plants, implications of altering natural habitats and cultural traditions, origins and histories of cultivated plants, development of agriculture and ecological aspects of its practices, including soil management, pest control, plant

breeding, and preservation of genetic diversity. Three lectures per week, plus one optional weekend field trip. Applies to the Ecology/Evolution major requirement. *Prerequisites:* Biology 111 and 112; or consent of instructor. Offered in alternate years.

303 Cell Biology

Spring

Danka

3 credits

The ultrastructure and function of cells. This course will examine in detail the major molecular processes in eukaryotic cells to include biological molecules, membranes and cell surfaces, cell signaling, cellular energetics and metabolism, motility, protein processing and transport, cell cycle regulation, etc. Principles will be illustrated by examining various scenarios that occur when cellular processes are disrupted, as in the case of cell-based diseases, including but not limited to cancer development. Three lectures per week. Applies to the Molecular/Cell major requirement. *Prerequisites:* Biology 205 and Chemistry 245. *Recommended Prerequisite:* Biology 112.

304 Cell Biology Laboratory

Spring

Danka

1 credit

The laboratory extension of Biology 303, the exercises will illustrate principles of eukaryotic cellular biology, with emphasis on modern instrumentation techniques, particularly protein isolation and cell culture techniques. One three-hour laboratory session per week. Applies to the Molecular/Cell major requirement. *Prerequisites:* Biology 303 or 305. *Recommended Prerequisite:* Biology 112. *Co-requisite:* Biology 303 or 305. *Lab fee:* maximum \$30.

305 Cellular Physiology and Signaling

Not offered 2019-20

3 credits

This class will cover the essentials of cell biology and can be used in place of Biology 303 to fulfill the cell biology requirement for biology majors (when taken concurrently with Biology 306) and is suitable as an elective for BBMB majors. In particular, this class will emphasize the role of cellular membranes and signaling machinery in regulating proper cell function. Diversity in cellular signaling will be illustrated through investigation of various strategies used to mediate changes in the physiology of single cells and potentially, the organism. Cell communication is critical to cell survival and adaptation. It is an area of biological study that incorporates biochemistry, cell biology/physiology and membrane biophysics — all of which will be specifically highlighted through literature review and discussion sessions. Three lectures per week. Applies to the Molecular/Cell major requirement. *Prerequisites:* Biology 111; Chemistry 245; or consent of instructor. *Corequisites (to fulfill biology major requirements): Recommended Prerequisite:* Biology 306. Chemistry 246.

306 Cellular Physiology and Signaling Lab

Not offered 2019-20

1 credit

Laboratory exercises in cellular biology will incorporate cell labeling, microscopy, biochemical analysis, and pharmacological manipulation to assess cell physiology (e.g., motility, metabolism, development, and signaling). One three-hour laboratory per week. Applies to the Molecular/Cell major requirement. *Pre- or corequisite:* Biology 305. *Lab fee:* maximum \$30.

310 Physiology

Fall

Coronado

4 credits

An advanced-level examination of the biological functions that allow self-maintenance, reproduction, and regulation in various environments. Animals in general will be covered, but we will emphasize mammals and humans. An initial overview examines the principles of traditional organ-systems physiology and how these are increasingly being altered by evolutionary biology, Darwinian medicine, molecular and cellular physiology, and genomics. This overview will be integrated with organismal functions including hormonal and neural regulation, defense, support and movement, excretion and osmotic balance, circulation and transport, respiration, energy balance, and reproduction. We will also discuss several disease models and how they disrupt normal physiology. This course will include three 50-minute lecture periods per week and one 3-hour laboratory section per week. Applies to the

Organismal major requirement. *Prerequisites:* Biology 111 and 205, or consent of instructor. *Recommended Prerequisite:* Biology 112; 303 and 304 or 305 and 306. *Lab fee:* maximum \$30.

315 Comparative Vertebrate Anatomy

Fall

K. Jackson

4 credits

The structure and function of vertebrates within an evolutionary context. By the end of the course students should have gained a familiarity with the structural diversity of the 60,000 or so living vertebrates and some of their extinct ancestors, a detailed knowledge of the anatomy of a few “representative” vertebrates studied in lab, and an understanding of the major structural trends and innovations in the history of vertebrates. Three lectures and one three-hour laboratory per week. This course is especially recommended for students planning careers in medicine or veterinary medicine or with an interest in evolutionary biology. Applies to the Organismal major requirement.

Prerequisites: Biology 111 and 112. *Lab fee:* maximum \$30.

316 Transformations in Vertebrate Evolution

Spring

K. Jackson

2 credits

This course explores major transformations that vertebrates have undergone in the course of their 500 million year history. For example, how and why did fishes first make the transition to land? How and why did whales (and ichthyosaurs, plesiosaurs, sea turtles and others) make the transition back to water from land? How did flying birds evolve from running dinosaurs? Drawing on the primary literature, from multiple levels of biological organization and integrating research from a range of disciplines (e.g. palaeontology, developmental biology, phylogenetic systematics, ecology), students will explore these and other important transformations in the evolutionary history of vertebrates. Applies to the Ecology/Evolution major requirement. *Prerequisites:* Biology 112 and 205;

Recommended Prerequisite: other 300-level Biology course.

317 Genetic Engineering in the 21st Century

Fall

Moss

2 credits

Recent scientific advances such as genome sequencing and CRISPR gene editing have enabled us to “hack” the very building blocks of life in microbes, plants, and animals. Will genetic engineering come to revolutionize the 21st century in the same way that computer engineering did in the 20th century? This advanced seminar course will explore the biological principles underlying genetic engineering technologies and the impact they are having on medicine, agriculture, and the environment. Most readings will come from the primary research literature, and the class will be a mix of presentation and discussion, with overviews and background material given by the instructor. Applies to the Molecular/Cell major requirement and as an elective for BBMB majors. *Prerequisite:* Biology 205.

319 Developmental Biology Seminar

Spring

Withers

2 credits

Only 30-50% of all human conceptions survive to birth, due to faults in cellular and molecular regulation of development, but even after birth, developing tissues continue to be vulnerable to insult. This upper level seminar course will focus on embryonic and early postnatal development and developmental disorders due to genetic mutations or environmental conditions. Most readings will come from the primary literature, and the class will be a mix of presentations and discussion, with overviews and background material given by the instructor. Applies to the Molecular/Cell major requirement. *Prerequisites:* Biology 111 and 205.

320 Neurobiology

Fall

Wallace and Withers

4 credits

This course emphasizes the cellular and molecular biology of neurons as a basis for understanding how the nervous system controls behavior. Topics include the structure and function of neurons and glia, synaptic transmission, brain development and regeneration, sensory and motor systems, brain mechanisms of learning and memory, clinical issues, and becoming a neuroscientist. The laboratories will emphasize hands-on experience with techniques used to study the brain in current research including neuroanatomy, neurocytology, neurophysiology, analysis of neuronal gene expression, and observation of living neurons in culture. Three hours of lecture and one three-hour laboratory

per week. Applies to the Molecular/Cell major requirement. *Prerequisites:* Biology 111 and 205. Biology 112 and 303 and 304 or 305 and 306 are recommended. *Lab fee:* maximum \$30.

323 Neurophysiology

Spring

T. Knight

4 credits

This course will introduce students to the multidisciplinary field of neurophysiology from cellular processes to integrated central and peripheral nervous systems functions. The course will examine core principles of neuroanatomy, membrane excitability, neuronal signaling, sensory and motor function, neuroendocrine regulation of integrated organismal physiology (e.g., cardiovascular), and abnormalities that give rise to neurological disorders. Laboratory exercises will emphasize core concepts and methodology, and may incorporate lectures/demonstrations by clinicians/patients and integrative case studies. Three lectures and one three-hour laboratory per week. Applies to the Organismal Biology major requirement. It is also a suitable elective for BBMB majors. *Prerequisite:* Biology 111. Biology 303 or 305 or BBMB 325 are highly recommended. *Lab fee:* maximum \$30.

327 Biology of Amphibians and Reptiles

Not offered 2019-20

3 credits

Herpetology is the study of amphibians and reptiles. In this course, taxonomy, life history, behavior, physiology, ecology, etc., of frogs, salamander, turtles, lizards, snakes, crocodiles, and others will be presented in the context of the evolutionary history of this diverse assemblage of vertebrates. In the course of the semester, students will prepare an essay on a herpetological topic of their choice. Three lectures per week. Applies to the Ecology/Evolution major requirement. *Prerequisites:* Biology 112, other organismic level courses desirable. *Optional corequisite:* Biology 337.

328 Evolutionary Developmental Biology

Not offered 2019-20

3 credits

Evolution and development are inexorably linked and genetics is the tie that binds them. This interdisciplinary class explores how genetic and developmental mechanisms have evolved to produce biological diversity. Through lectures, class discussions, and activities, and analysis of both classic and cutting-edge scientific papers, we will examine the contributions of all three research areas to the emerging field of “evo-devo”. Three lectures per week. Applies to the Organismal major requirement. *Prerequisite:* Biology 111 and 205. *Optional corequisite:* Biology 338.

329 Developmental Biology

Not offered 2019-20

4 credits

This upper-level course addresses how a complex multicellular organism arises from a single cell, the fertilized egg. The course is framed by questions formulated using classic experiments in experimental embryology and current molecular and cellular approaches that yield new answers to these questions. Emphasis is on how specialized form and pattern develop in animals; ethical and social issues relevant to developmental biology also are discussed. Labs emphasize independent experimentation and current techniques including time-lapse and digital microscopy of living cells and organisms. Three lectures and one three-hour laboratory per week. Applies to the Molecular/Cell major requirement. *Prerequisites:* Biology 111, 205; Chemistry 245. Biology 112, and Biology 303 and 304 or 305 and 306 or BBMB 325 are recommended. *Lab fee:* maximum \$30.

330 Human Physiology

Not offered 2019-20

4 credits

A survey of the functions of the human body using disease states to illustrate key physiological processes. This course will cover in detail the endocrine, nervous, muscular, cardiovascular, respiratory, digestive, renal, and immune systems and will offer an overview of integrative functions such as electrolyte and metabolic regulation. This course will examine a sample of pathological states as a springboard for understanding principles of physiology and use case studies to synthesize and apply knowledge from cellular/tissue processes to integrated organ-systems functions. Foundational principles of physiology will be investigated and emphasized through experimental

laboratory work. Lab sessions will also incorporate lectures or demonstrations by clinicians/patients and/or tours of hospital clinics. Applies to the Organismal Biology major requirement and is suitable as an elective for BBMB majors. Given extensive overlap with Biology 310, students may not take both courses for credit. Three lectures and one three-hour laboratory session per week. *Prerequisites*: Biology 111 and Chemistry 245; or consent of instructor. *Lab fee*: maximum \$30.

331 Synthetic Cell Biology

Fall

Moss

4 credits

Synthetic biologists take apart, rebuild, and repurpose parts of a cell in order to program and probe cell behavior. To do this, synthetic biologists utilize approaches from cell biology, engineering, molecular genetics, and biochemistry. This advanced course will survey the questions addressed by synthetic biology research, the molecular approaches utilized, and the implications of this work in the realms of biomedicine and agriculture. A key component of this survey will be the lab, wherein students will engage in a synthetic biology research project. Course-work will include reading and discussion of primary research literature, lectures to provide background information, student-led presentations, scientific writing, and hands-on lab work. The course will consist of 2.5 hours of lecture/discussion and one 3-hour lab per week. Applies to the Molecular/Cell major requirement and as an elective for BBMB majors. Students who received credit for BIOL 374 ST: *Molecular and Synthetic Biology* cannot receive credit for this course. *Prerequisites*: Biology 205 and Chemistry 245. *Lab fee*: maximum \$30.

337 Biology of Amphibians and Reptiles Lab

Not offered 2019-20

1 credit

Labs will focus on study of preserved specimens, and identification of amphibian and reptile species from all over the world. Students also will learn to identify all local species. One three-hour lab per week. Applies to the Ecology/Evolution major requirement. *Corequisite*: Biology 327. *Lab fee*: maximum \$30.

338 Evolutionary Developmental Biology Lab

Not offered 2019-20

1 credit

The Evolutionary Developmental Biology Lab is designed to accompany the associated lecture course (Biology 328). Students will gain hands-on experience in acquiring and analyzing data using a variety of techniques common in the field of “evo devo”, and will then work in small groups to apply these skills to develop and test hypotheses regarding a “mystery” developmental mutant of either the mustard plant *Arabidopsis* or the fruit fly *Drosophila*. Applies to the Organismal major requirement. *Prerequisite*: Biology 111 and 205. *Optional corequisite*: Biology 328. *Lab fee*: maximum \$30.

339 Microbiology and Immunology

Fall

Danka

4 credits

Bacteria, viruses, and eukaryotic microbes. Cell structure and chemistry, metabolism, evolution, and ecology will be themes emphasized throughout the course as other topics such as pathogenesis, disease, the immune system, cultivation, taxonomy, and practical applications for microorganisms are discussed. The laboratory will establish sterile techniques and stress the structure and biochemical differentiation of bacterial species. Three lectures and one three-hour laboratory per week. Applies to the Molecular/Cell major requirement. *Prerequisites*: Biology 111 and a year of college chemistry. Biology 112 is recommended. *Lab fee*: maximum \$30.

342 Gene Discovery and Functional Genomics

Spring

Vernon

2 credits

An advanced course providing an introduction to how biologists discover genes and determine their roles in diverse biological processes in both plants and animals. Research literature will provide examples of gene identification by forward genetics, molecular methods, and genomics. We will discuss genome annotation and functional analysis by reverse genetics, transcriptome studies, and other genome-based methods. Class will include reading and discussion of primary research literature, lectures to provide background information, student presentations, and some hands-on work with genome databases and DNA analysis. Some familiarity with recombinant DNA techniques and

molecular methods covered in Genetics is expected. Applies to the Molecular/Cell major requirement for Biology majors. *Prerequisites:* Biology 205 and Chemistry 246.

350 Evolutionary Biology

Fall

Hutchison

4 credits

Designed for the upper-level biology major, this course emphasizes the importance of evolutionary theory to biology. Using modern examples in population biology, molecular evolution and phylogenetics, students will gain a firm foundation in the mechanisms of evolution, speciation, and extinction, and an appreciation of the applicability of evolutionary principles to current issues in areas such as conservation, medicine, and social behavior. Three lectures and one three-hour lab per week. Applies to the Ecology/Evolution major requirement. *Prerequisites:* Biology 111 and 205. Biology 112 and 277 or 215 are recommended. *Lab fee:* maximum \$30.

351 Exercise Physiology

Spring

Coronado

4 credits

Students will be introduced to exercise physiology and receive an overview of the foundations of exercise, the role of body systems, the importance of nutrition and environment and impact of exercise training on performance and health. Current topics as well as research and clinical relevance will be presented through lectures, case studies, required reading and laboratory activities. Students will be evaluated by quizzes, discussions, case study questions, laboratory reports, a midterm and a final exam. By the end of the course, students will have developed a background in exercise physiology and the ability to apply that knowledge in a real-world setting. The course will include three 50-minute lectures and one three-hour laboratory section per week. Applies to the Organismal Biology major requirement and as an elective for BBMB majors. *Prerequisites:* Biology 111 and 205; or consent of instructor. *Lab fee:* maximum \$30.

371- 374 Special Topics in Biology

1-4 credits

Any current offerings follow.

401, 402 Seminar

1-3 credits

Selected advanced topics in biology. Examples of recently offered topics include bioethics, evolution, and nutrition. Course topic and credit to be designated by instructor. Students will be expected to complete readings, make presentations, and participate in discussions about the selected topics. The topic and course credit will be designated prior to registration for the semester in which a seminar is offered; consult the chair of the department for information. Any current offerings follow.

471, 472 Special Topics

1-5 credits

Lectures (possibly with laboratories) on advanced topics in biology not generally covered in other courses in the department. Examples of topics offered include plant systematics, invertebrate biology, biology of amphibians and reptiles, entomology, and immunology. The topic and course credit will be designated prior to registration for the semester in which a special topic is offered. Any current offerings follow.

481, 482 Special Projects

Fall, Spring

Staff

1-4 credits

Selected topics of an experimental or descriptive nature, arranged with individual students who are prepared to undertake semi-independent work. The students will consult with the faculty member most closely associated with the area of interest to determine if the topic is suitable and can be successfully accomplished with the available material and library facilities. This consultation should take place in the semester preceding the anticipated research project. *Prerequisite:* consent of the supervising instructor.

489 Thesis Research and Data Analysis**Fall, Spring****Staff****1 credit**

Research or data analysis to be described in senior thesis and seminar (Biology 490). Projects may involve laboratory experiments, fieldwork, and/or data analysis, and can be carried out in the senior, junior, and/or sophomore year. Students must register with a research/thesis adviser from biology or BBMB, and the research itself must be carried out with guidance from that adviser, or (if done off-campus), a qualified research supervisor.

Prerequisite: consent of research/thesis adviser, and senior standing as a biology major.

490 Senior Thesis**Fall, Spring****Staff****2 credits**

Continuation of Biology 489. Each student will finish data collection and write a thesis on the research in accepted scientific style. One or more initial drafts of the thesis will be required before the final version is due in the last week of classes. Each student also is required to give a short seminar presentation of his/her results to the faculty and other biology majors. *Prerequisite:* Biology 489 (may be taken concurrently by students completing requirements in December) or consent of supervising professor.

498 Honors Thesis**Fall, Spring****Staff****2 credits**

Continuation of Biology 489 and required of senior honors candidates. Honors students will finish data collection and write a thesis on the research in accepted scientific style. One or more initial drafts of the thesis will be required before the final version is due in the library. Presentation of results to the staff and other biology majors is required. Students register for Biology 490, but are awarded credits in Biology 498 if honors are earned. Credit cannot be earned simultaneously for Biology 498 and 490. *Prerequisites:* Biology 489, consent of supervising professor, and admission to honors candidacy.

499 Senior Seminar**Spring****Parker****1 credit**

Each student will attend a weekly, one-hour seminar where students present the results of their senior theses. Course is graded credit/no credit. Open only to senior Biology majors.