BIOLOGY
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SM 011. Humans in a Microbial World. (M) Living World Sector. All classes. Brisson. May not be counted toward the Biology major or minor

Microbes are a fundamental part of life on this planet. This course will explore the causes and consequences of the distribution and abundance of microbes (microbial ecology) as well as microbial evolution on human health and disease risk. We will address the interplay between human society and microbial ecology and evolution in shaping disease risk and directing scientific study. This course will apply concepts from basic biology, ecology, and evolution to study infectious microbes as living creatures.

SM 014. Descent with Modification: An introduction to the science of evolution. (H) Living World Sector. All classes. Sniegowski. May not be counted toward the Biology major or minor. General biology background preferred but not required

Evolution provides the unifying framework for the biological sciences and has been confirmed by a huge and diverse body of evidence. Public opinion polls show, however, that evolution continues to be socially and politically controversial in the United States. In this freshman seminar, we will explore the scientific basis for evolution by reading and discussing historical sources, a current nonspecialist text on evolution, and selected papers and articles from the scientific and popular literature. With our knowledge of evolutionary fact and theory as background, we will also discuss social and political opposition to the teaching of evolution. Grading will be based on participation in class discussions and on performance in several brief writing assignments. There is no course prerequisite, but high school introductory biology would be helpful.

L/R 015. Biology of Human Disease. (B) Living World Sector. All classes. Weinberg. May not be counted toward the Biology major or minor

Understanding how diseases disrupt the life of human individuals requires an appreciation of the genetic, biochemical, and cellular mechanisms that underlie normal human biology. After providing some of this basic information, in a form accessible to students in the humanities, social sciences and physical sciences, this course will focus on a selective group of human diseases, including inherited metabolic and neurological disorders, cancer, and viral infections. Presentations by experts in these areas will be followed by sessions discussing various aspects of each disease, including the biological basis of therapies and preventive methods including gene therapy, stem cells, and vaccines. This course is designed for non-majors and is open to both freshmen and upperclassmen.

017. The Biology of Food. (A) Living World Sector. All classes. Poethig. May not be counted toward the Biology major or minor. Lab fee $75

This course will examine the ways in which humans manipulate - and have been manipulated by - the organisms we depend on for food, with particular emphasis on the biological factors that influence this interaction. The first part of the course will cover the biology, genetics, evolution, and breeding of cultivated plants and animals; the second part will concern the ecological, economic, and political factors that influence food production. Lab activities include demonstrations and field trips to local farms.

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019. Biological Science and Public Policy. (A) Staff.Prerequisite(s): High school biology recommended. May not be counted toward the Biology major or minor. Only offered through the College of Liberal and Professional Studies

This course will examine the scientific basis of public policy decision making in areas of human health, the environment, energy, and agriculture. A general understanding of the science involved in these areas - predominantly genetics, cell biology, physiology, and ecology - will be applied to topics such as drug and herbicide resistance, endangered species, regulation of biotechnology, microbial sources of energy, control of toxic substances, and the war against cancer. No formal background in biology or policy is required. The course should be particularly useful for non-science students who would like to gain insight into areas of biology of importance to public decision making and to students of public policy who would like a better background on biological issues.

SM 021. This is Your Genome! - Fascinating Experiments in Heredity. (A) Guild. May not be counted toward the Biology major or minor

Your genome represents the complete set of genetic instructions that guides your development from a single cell into a living, thinking, and reproducing organism. This course will examine the ideas that led to our current understanding of genomes with particular emphasis on the molecular biology that revolutionized our concepts of gene and genome structure and function. We will fast-forward through the heredity/chromosome/DNA/gene-structure era and spend some time in the genome-sequencing era of the late 1990s and early 2000s. We will then consider how genome science is revolutionizing our understanding of gene variation, human disease, population biology and evolution. The course will include field trips to the Penn genomic core facilities.

101. Introduction to Biology A. (C) Living World Sector. All classes. Staff. (3 hrs. lec., 3 hrs. lab, 1.5 c.u.) Biology majors and pre-medical students should take either BIOL 101 or 121. BIOL 101 is the companion course to BIOL 102 and should be taken before BIOL 102. Lab fee $150

General principles of biology focusing on the basic chemistry of life, cell biology, molecular biology, and genetics in all types of living organisms. Particular emphasis will be given to links between the fundamental processes covered and current challenges of humankind in the areas of energy, food, and health.

102. Introduction to Biology B. (C) Living World Sector. All classes. Staff. (3 hrs. lec., 3 hrs. lab, 1.5 c.u.) BIOL 102 is the companion course to BIOL 101 and should be taken after BIOL 101. Lab fee $150

General principles of biology focusing on structure and function of animals, with emphasis on the principles of physiology, development, evolution, ecology, and the diversity of adaptations.

109. (BIBB109, PSYC109) Introduction to Brain and Behavior. (C) Living World Sector. All classes. Kane and McLean. Lab fee $75

Introduction to the structure and function of the vertebrate nervous system. We begin with the cellular basis of neuronal activities, then discuss the physiological basis of motor control, sensory systems, motivated behaviors, and higher mental processes. This course is intended for students interested in the neurobiology of behavior, ranging from animal behaviors to clinical disorders.

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L/R 121. Introduction to Biology - The Molecular Biology of Life. (A) Living World Sector. All classes. Staff.Prerequisite(s): Solid high school biology and strong high school chemistry or CHEM 101. Corequisite(s): BIOL 123 is recommended.Biology majors and pre-medical students should take either BIOL 101 or 121. BIOL 121 is the companion course to BIOL 124 and may be taken before or after BIOL 124

An intensive introductory lecture course covering the cell, molecular biology, biochemistry, and the genetics of animals, bacteria, and viruses. This course is comparable to Biology 101, but places greater emphasis on molecular mechanisms and experimental approaches. Particular attention is given to the ways in which modern cell biological and molecular genetic methods contribute to our understanding of evolutionary processes, the mechanistic basis of human disease, and recent biotechnological innovations. Students are encouraged to take BIOL 121 and 123 concurrently.

123. Introductory Molecular Biology Laboratory. (C) Hogan. Corequisite(s): BIOL 121 or credit by exam for BIOL 101 or 121.(1 hr. lec., 3 hrs. lab, 0.5 c.u.) Students may not take both BIOL 101 and 123 for credit. Lab fee $150

An intensive introductory laboratory course emphasizing how molecular biology has revolutionized our understanding of cell and organism functions. BIOL 121 and 123 should be taken concurrently.

124. Introductory Organismal Biology Lab. (C) Robinson.Prerequisite(s): Solid high school biology or credit by exam for BIOL 102. (1 hr. lec., 3 hrs. lab, 0.5 c.u.) BIOL 124 is the companion course to BIOL 121 and may be taken before or after BIOL 121. Students may not take both BIOL 102 and 124 for credit. Lab fee $150

An intensive introductory laboratory course in organismal biology.

140. (BIOL440) Humans and the Environment. (A) Natural Science & Mathematics Sector. Class of 2010 and beyond. Janzen.Prerequisite(s): Sophomore standing or greater. Some biology background suggested.

Intensive exposure to current issues and solutions in contemporary human interactions with the environment. Global in scope, but focused on case histories. Emphasis on providing biological and sociological background for a given major environment-human interaction, and state-of-the-art suggested solutions.

199. Clinical & Translational Research. (C)

Independent study for students doing research based on data that is generated in a clinical setting. Projects must be sponsored by standing faculty of the University of Pennsylvania and co-sponsored by a faculty member in the Department of Biology. The project must be of biological interest and must use appropriate quantitative or statistical methods. A final paper is required. Apply at the Academic Office, 102 Leidy Labs.

L/R 201. Essentials of Cell Biology. (C) Staff.Prerequisite(s): BIOL 101 and 102 or BIOL 121/123 or equivalent courses.

An intermediate level exploration of cell structure and function including membrane structure, intracellular organelles, membrane trafficking, surface receptors and signal transduction, the cytoskeleton, cell motility and communication, and the cell cycle. This course is open to students in the College of Liberal and Professional Studies only.

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L/R 203. Essentials of Biochemistry. (C) Staff.Prerequisite(s): BIOL 101 and 102 or BIOL 121, and CHEM 241, the latter of which may be taken concurrently. CHEM 242 is recommended and may also be taken concurrently.

Intermediate level course covering principles of modern biochemistry. Topics include protein structure, protein purification and characterization, proteomics, enzyme kinetics and mechanisms, membrane structure and function, metabolism, and cellular energy transduction. Emphasis will be on biochemical problem solving, experimental design, and application of quantitative methods in a biological and clinical context. This course is open to students in the College of Liberal and Professional Studies only.

L/R 204. Biochemistry. (B) Rea.Prerequisite(s): BIOL 101 and 102 or BIOL 121, and CHEM 241, the latter of which may be taken concurrently. CHEM 242 is recommended and may also be taken concurrently.

BIOL 204 examines the basic principles of protein structure, protein purification and characterization, proteomics, enzyme kinetics and mechanism, membrane structure and function, metabolism, and cellular energy transduction. The primary objective is to provide life scientists with an appreciation of basic principles of modern biochemistry, and of how the current conceptual and technical framework arose. Emphasis is placed on the experimental approaches and reasoning behind the dissection and reconstitution of these processes in a biological and, in some cases, clinical context. Discussions directed at biochemical problem solving, experimental design and the application of quantitative methods are integral to the course.

L/R 205. Cell Biology. (A) Guo and Svitkina.Prerequisite(s): BIOL 101 and 102, or BIOL 121.

A conceptual view of cell structure and function including membrane structure, intracellular organelles, membrane trafficking, surface receptors and signal transduction, the cytoskeleton, cell motility and communication, and the cell cycle. Cell biology is a dynamic field and recent research discoveries will be included in the lectures.

L/R 211. Essentials of Molecular Biology and Genetics. (C) Staff.Prerequisite(s): BIOL 101 and 102 or BIOL 121/123 or equivalent courses.

This course will survey the discipline of molecular genetics. Mendelian and molecular genetics will be discussed as well as the use of genetic analysis to address questions in all areas of biology. The processes of DNA replication, transcription, and translation will be discussed at the molecular level. Other topics include the regulation of gene expression and genomics. This course is open to students in the College of Liberal and Professional Studies only.

L/R 213. Essentials of Vertebrate Physiology. (C) Staff.Prerequisite(s): BIOL 101 and 102 or BIOL 121/123 and 124 or equivalent courses.

A comparative and quantitative approach to the physiological function of vertebrates. Topics include muscles, nervous system, cardiovascular system, respiration, and renal function. This course is open to students in the College of Liberal and Professional Studies only.

L/R 215. Vertebrate Physiology. (C) Rome/Ren/Dunham.Prerequisite(s): BIOL 102 or 121 or 124.

The course will focus on integrative aspects of physiological function of vertebrates. Comparative, environmental and quantitative approaches will be used. Major topics include muscle, the cardiovascular system, respiration, renal function and the nervous system.

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L/R 221. (BIOL527, GCB 527) Molecular Biology and Genetics. (C) Bonini/Gallagher/Guild.Prerequisite(s): BIOL 101 or 121.

This course will survey the discipline of molecular genetics. Two broad areas will be considered 1) Molecular Biology: DNA replication, transcription, translation, regulation of gene expression in both prokaryotic and eukaryotic systems, and genomics and 2) Genetics: basic Mendelian & molecular genetics.

L/R 230. Evolutionary Biology. (B) Schmidt, P.Prerequisite(s): BIOL 101 and 102, or BIOL 121.

Theories and mechanisms of evolution, with emphasis on the genetic basis of evolutionary change.

231. (BIBB231, PSYC231) The Evolution of Animal Behavior. (M) Cheney/Seyfarth.Prerequisite(s): BIOL 102 or 121 or PSYC 001.

The evolution of social behavior in animals, with special emphasis on group formation, cooperation among kin, mating systems, territoriality and communication.

240. Ecology: From individuals to ecosystems. (A) Helliker/Akcay.Prerequisite(s): BIOL 102 or 121.

The study of living organisms in their natural environment, spanning the ecological physiology of individuals, the structure of populations, and interactions among species, including the organization of communities and ecosystem function.

251. (BIBB251) Molecular and Cellular Neurobiology. (A) Schmidt, M./Abel/Kaplan.Prerequisite(s): BIOL 101 and 102, or BIOL 121; PHYS 102 or 151 strongly recommended. (3hrs. lec., 3hrs. lab, 1.5 c.u.). Lab fee $150

Cellular physiology of neurons and excitable cells, molecular neurobiology and development. Topics include: action potential generation, synaptic transmission, molecular and physiological studies of ion channels, second messengers, simple neural circuits, synaptic plasticity, learning and memory, and neural development.

275. Fundamental Microbiology. (C) Staff.Prerequisite(s): BIOL 101 or 121, BIOL 211 or 221 or equivalent strongly recommended. Combined lecture and lab course. Lab fee $150

Microbiology plays a central role in diverse areas of human life such as infectious disease, ecology, and biotechnology. This course will cover aspects of modern microbiology with an emphasis on prokaryotic organisms. The topics will include basic aspects of microbial diversity, genetics, and pathogenesis as well as examples of applied microbiology. This course is open to students in the College of Liberal and Professional Studies only.

304. Infectious Disease Biology. (B) Staff.Prerequisite(s): BIOL 221, 275, and 404, the later of which may be taken concurrently.

This course focuses on selected topics concerning infectious agents, the diseases they cause in humans, and the social and scientific challenges they pose. The first section addresses the principles of epidemiology and microbial pathogenesis, as well as pathophysiology of infectious diseases. In the second section, tools and techniques of diagnosis, tracking, and control of infectious diseases will be discussed. To develop a broad understanding of the many different aspects of infectious processes, selected viral, fungal, protozoan, and helminthic pathogens and related infectious diseases will be presented. This course is open to students in the College of Liberal and Professional Studies only.

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306. Histology. (C) Prerequisite(s): BIOL 101 and 102 or BIOL 121, and BIOL 201, 202, or 205 preferred. Lab fee $150

This course is designed to introduce the undergraduate student to the structure of tissues at the cellular level and to the way in which those tissues are assembled into organs. This knowledge of structure will be the basis for discussion of tissue and organ function. This course is open to students in the College of Liberal and Professional Studies only.

330. Comparative Vertebrate Anatomy and Evolution. (B) Dunham.Prerequisite(s): BIOL 102 or 121.

This course will survey the phylogeny and anatomy of vertebrate organisms from a comparative evolutionary perspective. The lecture will concentrate on the history, diversity, structure and function of vertebrates. A companion lab course, BIOL 336, is available for those students interested in a more complete understanding of vertebrate anatomy.

336. Comparative Vertebrate Anatomy Lab. (B) Dunham.Prerequisite(s): BIOL 330 previously or concurrently is required. (3 hrs lab., 0.5 c.u.). Lab fee $150

Laboratory portion of BIOL 330 Comparative Vertebrate Anatomy and Evolution. Students will learn comparative anatomy through dissection of representative vertebrates. Students taking the lab must have credit or register for the lecture course, BIOL 330.

399. Independent Study. (C)

Laboratory research with a faculty member in the Department of Biology. Research may also be conducted elsewhere on campus but co-sponsored by a faculty member in Biology. A final paper is required. Apply at the Biology Academic Office, 102 Leidy Labs.

L/R 354. Developmental Biology. (A) Wagner J.Prerequisite(s): BIOL 202 or 205 and 221.

A view of how an animal embryo is specified to develop and differentiate into a wide spectrum of cell types, and how the spatial patterns and axes of embyros are determined. The course will focus on genetic and molecular approaches, but will also cover the comparative anatomy of developing embryos to the extent necessary to understand the conserved aspects of embryonic patterning. Special emphasis will be placed on organisms with particular advantages for the study of embryonic development: e.g., mouse, frog, zebrafish, and Drosophila. The first half of the course will cover cell fate restrictions, cloning animals using nuclear transfer, stem cell biology, formation of the embryonic axes in vertebrates and Drosophila, and patterning of the neural tube and mesodermal tissues. The second half of the course will focus on emerging ideas and findings in the field, with emphasis on analysis of original literature.

375. (BIOL575) Microbial Diversity and Pathogenesis. (B) Pohlschroder.Prerequisite(s): BIOL 101 and 102 or BIOL 121, BIOL 221.

Microbiology plays a central role in diverse areas of human life such as infectious disease, ecology, and biotechnology. This course will cover aspects of modern microbiology with an emphasis on prokaryotic organisms. The topics will include basic aspects of microbial diversity, genetics, virology, and pathogenesis as well as examples of applied microbiology.

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376. (BIOL576) Microbial Diversity and Pathogenesis Lab. (B) Pohlschroder and Hogan.Prerequisite(s): BIOL 375 previously or concurrently is recommended but not required. (6 hrs lab., 1.0 c.u.). Lab fee $150

The importance of microbiology in complex issues, such as the impact of the microbiome in human health or as alternative energy sources, is being appreciated more and more each day. This upper level laboratory course provides students with a robust technical skill set while also giving them an opportunity to participate in an authentic research project that may lead to novel discoveries. Students will generate research questions, formulate hypotheses, design experiments, analyze data, and present their research findings to the class. In each project, students will use the cutting edge approach of metagenomics to evaluate the microbial diversity of their environment via Next Generation Sequencing. Students will also examine the function of microbial species within their communities. Potential projects include the isolation of novel antibiotic producers and the antibiotic they produce, designing and optimizing microbial fuel cells that can be used to generate electricity, or isolating antibiotic resistant bacteria and attempting novel approaches to inhibit or prevent their growth.

400. Field Botany. (A) Block and Skema.Prerequisite(s): BIOL 101 or 124 or permission of instructor.

Students will learn to identify plants in the field using keys and manuals; lab exercises will also include the use of quantitative techniques for measuring plant populations and characterizing plant communities. Students will learn how to collect and prepare herbarium specimens. Most of the class time will be spent outdoors and two Saturday field trips are required.

404. Immunobiology. (C) Staff.Prerequisite(s): BIOL 201 or 202 or 205 and BIOL 211 or 221.

Early development of microbiology, pathology, and immunobiology; molecular and cellular bases of immune phenomena including: immunity to pathogens, immune diseases, autoimmunity, and hypersensitivity. This course is open to students in the College of Liberal and Professional Studies only.

SM 405. First Line of Defense: The Role of Innate Immunity in Disease. (B) Elliott.Prerequisite(s): BIOL 202 or 205, or permission of instructor, BIOL 221 recommended.

All organisms, from bacteria to humans, rely on innate, non-specific defense systems to protect against infection and mediate damage. Even in organisms that can generate highly specific and efficient adaptive responses, such as humans, defects in innate immune system components can be fatal. In this course, we will examine the cellular and molecular mechanisms of the components of the innate immune system through discussion of primary literature. We will explore how the innate immune system influences the course of infections and cancer, as well as autoinflammatory disorders that lead to host tissue damage. Though our focus will be on mammalian immunity, we will also explore the evolutionary development of innate immunity through comparison of systems in different organisms.

SM 406. Molecular Mechanisms of Infectious Disease Biology. (B) Roos.Prerequisite(s): BIOL 202 or 205; BIOL 221 recommended.

This course is designed for advanced undergraduates and beginning graduate students with a particular interest in infectious disease biology. Note that this course is not a comprehensive survey of the field and is not appropriate for students seeking a lecture course on disease. The primary objective of this course is to teach students considering a career in the biomedical sciences how to read, discuss, and question research papers effectively. Intensive classroom discussions focus on the experimental methods used, results obtained, interpretation of these results in the context of pathogen interactions with host cells and organisms, and implications for basic research and therapeutic development.

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SM 407. Cancer Cell Biology. (B) Keith.Prerequisite(s): BIOL 202 or 205 and 221.

This course will focus on the molecular mechanisms by which fundamental cellular processes are disrupted in the development of cancer.

410. Advanced Evolution. (I) Sniegowski/Plotkin.Prerequisite(s): BIOL 230 or permission of instructor.

Mechanisms of evolution at the genetic and populational levels. Empirical and theoretical approaches to natural selection, population structure, gene flow, and quantitative genetics will be emphasized.

SM 417. Theoretical Population Biology. (B) Akcay.Prerequisite(s): BIOL 230.

Introduction to basic theoretical tools to study the evolutionary and ecological dynamics of populations. Topics to be discussed include: basic population dynamics and population genetics theory, evolutionary game theory/adaptive dynamics, social evolution (kin selection/multilevel selection), life-history evolution, and stochastic models. Other topics may be added based on the specific interests of students in the class.

SM 411. Evolutionary Ecology. (B) Linksvayer.Prerequisite(s): BIOL 230 or 231 or 240.

This course will focus on topics at the intersection of evolutionary biology and ecology, including the evolution of cooperation and conflict from genes to societies to ecological communities, life history evolution, and the evolution of interspecific interactions and ecological communities. The course will use a combination of lectures and discussion of readings from the primary literature.

414. Advanced Ecology. (H) Helliker/Akcay.Prerequisite(s): BIOL 240 and one semester of calculus or permission of instructor.

Theoretical and conceptual background of core issues and questions in population, community, and ecosystem ecology. Topics include physiological ecology, demography, the growth and regulation of natural populations, species interactions, and biogeochemical cycling.

415. (ENVS416) Freshwater Ecology. (B) Arscott.Prerequisite(s): BIOL 101 or 121 and one semester of college chemistry.

Survey of the physical, chemical and biological properties of freshwater ecosystems, both riverine and lentic, natural and polluted.

L/R 421. Molecular Genetics. (A) Weinberg.Prerequisite(s): BIOL 221 or equivalent course.

A detailed analysis of gene structure and expression in both prokaryotic and eukaryotic organisms. Rapid advances in DNA technology and genomics will be emphasized. The application of these advances to the molecular genetic analysis of development, cell function and disease will be discussed.

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422. (CAMB422) Human Genetics and Genomics. (K) Tishkoff.Prerequisite(s): BIOL 221.

In this course we will discuss the identification and characterization of genetic diversity in the human genome, the genetic basis of normal variable traits, and the genetic basis of human disease. The study of the human genome increasingly impacts almost every aspect of our society, from medicine to law enforcement to how we view ourselves. The focus of this course will be to apply concepts and methods of genetics and genomic analysis (gene mapping, genome sequencing, epigenetics, gene expression) to better understand the genetic basis of both normal variable traits as well as disease. We will discuss how to distinguish the evolutionary and demographic forces (i.e. mutation, migration, selection, population size) that influence genotypic and phenotypic variation within and among human populations. We will discuss how genomics and population genetics methodologies are being applied to study modern human origins, analysis of ancient DNA, ancestry, and population history. We will also discuss the implications of these studies for personalized medicine.

425. Biochemistry and Molecular Genetics Superlab. (C) Wagner J.Prerequisite(s): BIOL 202 or 204 or 205 or 221 or an equivalent course is recommended. Lab fee $150

Intensive laboratory class where open-ended, interesting biological problems are explored using modern lab techniques. Topics may include protein structure/function studies; genetic screens, genomics and gene expression studies; proteomics and protein purification techniques; and molecular cloning and DNA manipulation. The course emphasizes developing scientific communication and independent research skills. Course topics reflect the interests of individual Biology faculty members. This course is recommended for students considering independent research.

431. (CAMB431) Genome Science and Genomic Medicine. (B) Gregory.Prerequisite(s): BIOL 221; BIOL 421 strongly recommended.

This course will be a focused study of genomes, genomic techniques, and how these approaches are and will be used in diagnosing and treating human disease. Topics will include genome sequencing, analysis of sequences and microarrays, and new techniques including high-throughput sequencing and reverse genetic analysis with a focus on genome-wide mutant collections.

SM 432. (BIBB432, PSYC431) Animal Cognition. (M) Cheney.Prerequisite(s): BIOL 231/BIBB 231/ PSYC 231.

This course considers the sorts of knowledge that animals have of their environment, their location in space, and their conspecifics. How do different animal species remember where food is located or find their way home? What is the adaptive significance of recognizing other individuals' social relationships or dominance ranks? The behavior of animals from a variety of different taxa is considered, ranging from invertebrates to apes. Emphasis is placed on animals living under natural conditions, though some research on learning and memory in captive animals is also discussed.

SM 436. Molecular Physiology. (A) Ren.Prerequisite(s): A year of introductory biology or equivalent.

This course is designed for advanced undergraduate and graduate students who are interested in molecular physiology of sensory signal transduction. The major topics to cover will be signal transduction mechanisms used by membrane ion channels and receptors that detect the sensory stimuli (light, sound, temperature and taste, for example) and transmit the signals to the nervous system. Modern molecular/structural techniques (patch clamp, protein crystallization, molecular genetics, expression cloning and protein purification) will be introduced along with each topic. References will be primary research articles. Students will critically evaluate research discoveries by reading and presenting one to two original research papers. Each student is required to write a 10-page research proposal and to critique proposals written by fellow students.

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442. (BIBB442, NGG 575, PSYC421) Neurobiology of Learning and Memory. (A) Abel.Prerequisite (s): BIOL 251/BIBB 251 and PSYC 1, or permission of instructor.

This course focuses on the current state of our knowledge about the neurobiological basis of learning and memory. A combination of lectures and student seminars will explore the molecular and cellular basis of learning in invertebrates and vertebrates from a behavioral and neural perspective.

437. (CIS 536, GCB 536) Introduction to Computational Biology & Biological Modeling. (A) Kim.Prerequisite(s): Intermediate level biology; MATH 104; BIOL 446 or equivalent.

Biology is flooded with data that cannot be understood without computational analysis and modeling. Computational Biology is a subfield of natural science where quantitative approaches are used to discover and understand biological and medical phenomena. The goal of this course is to develop a deep understanding of techniques and concepts used in Computational Biology. The course will strive to focus on a small set of approaches to gain both theoretical and practical understanding of the methods. We will aim to cover practical issues such as programming and the use of programs, as well as theoretical issues such as algorithm design, statistical data analysis, theory of algorithms and statistics. Topics to be discussed include theory of computing, probability theory, multivariate statistics, molecular evolution, and network models. Grading is primarily based on 3 project reports.

438. Systems Biology: Integrative physiology and biomechanics of the muscular system. (B) Rome.Prerequisite(s): 1 year physics, 1 year chemistry, and BIOL 215 or 251.

The course will focus on muscle function from the level of molecules to whole animal locomotion. At each level of organization, muscle function will be explored from mechanical and energetic viewpoints. The course will include lectures, demonstrations, and several guest expert lectures. Students will also be introduced to realistic musculo-skeletal modelling and forward dynamic simulations to explore integrated function.

440. (BIOL140) Advanced Analysis of Humans and the Environment. (A) Natural Science & Mathematics Sector. Class of 2010 and beyond. Janzen.Prerequisite(s): Permission of instructor.

Advanced version of BIOL 140: Humans and the Environment. Additional readings and course work as directed.

446. Statistics for Biologists. (A) Plotkin.Prerequisite(s): MATH 104 or equivalent; or permission of instructor.

Introductory probability theory. Principles of statistical methods. Problems of estimation and hypothesis testing in biology and related areas.

448. Principles of Drug Action. (A) Manning.Prerequisite(s): BIOL 202 or 205; BIOL 204 is recommended.

Principles of Drug Action covers the concepts of pharmacological sciences as they relate to biochemistry, cell biology, and drug therapy. The intent of the course is to provide a solid grounding in targets of drug action, dose-response relationships, pharmacodynamics, and pharmacokinetics. The grounding is achieved by a discussion of these concepts explicitly and, through selected examples, implicitly. The first part of the course covers each of the concepts. Emphasis is placed on the integration with principles of cell biology and biochemistry. The second part of the course covers selected therapeutic applications. The applications chosen fall within four areas: cardiovascular, brain and behavior, antipyretic and anti-inflammatory, and antimicrobial. They are used to recapitulate important concepts and provide insight into the interplay between pharmacology and human physiology. The applications and the areas they represent are by no means comprehensive, but students will be able to pursue additional interests through papers.

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451. (BIBB479, PSYC479) Neural Systems and Behavior. (B) Schmidt, M./Medina.Prerequisite(s): BIOL 251/BIBB 251 and permission of instructor.

This course will investigate neural processing at the systems level. Principles of how brains encode information will be explored in both sensory (e.g. visual, auditory, olfactory, etc.) and motor systems. Neural encoding strategies will be discussed in relation to the specific behavioral needs of the animal. Examples will be drawn from a variety of different model systems.

466. Molecular Genetics of Neurological Disease. (A) Bonini.Prerequisite(s): BIOL 221 is required; BIOL 251 and BIOL 421 are recommended.

This course will focus on the molecular basis of neurological diseases, exploring in detail key papers that cover topics including defining the disease genes, development of animal models that provide mechanistic insight, and seminal findings that reveal molecular understanding. Diseases covered will include neurological diseases of great focus today such as Alzheimer's, Fragile-X and autism, dementia, motor neuron degeneration, and microsatellite repeat expansion disorders. The course will provide a perspective from initial molecular determination through current status. Students will gain an understanding of how the molecular basis of a disease is discovered (from classical genetics to modern genomics) and how such diseases can be modeled in simple genetic systems for mechanistic insight. The course will be comprised of lectures with detailed analysis of primary literature and in-class activities. Grading will be based on class participation, exams, and written papers.

SM 469. Plant Physiology Through Space and Time. (B) Helliker.Prerequisite(s): BIOL 240 or permission of instructor.

This course is a lab/lecture/seminar hybrid that will meet once per week for three hours. Each session will consist of mini-lecture/lab, paper discussions/lab, or solely lab efforts. We will examine various aspects of photosynthesis, water relations and nutrient acquisition in the context of the evolutionary progression of higher plants. With each subject, we will consider, measure, and in some cases model whole-plant physiology while examining sub-cellular-level controls and ecosystem-to-global-level consequences. This course is designed to give molecular biologists through earth-system scientists the tools to measure and understand whole-plant physiological responses to molecular manipulation and environmental variability. All students will learn to appreciate the context of their work on both micro and macro scales.

483. (CAMB483) Epigenetics. (A) Wagner D.Prerequisite(s): BIOL 221.

This course investigates epigenetic phenomena: heritable alternate states of gene activity that do not result from an alteration in nucleotide composition (mutations). Epigenetic mechanisms regulate genome accessibility and cell differentiation. They play a key role in normal development and in oncogenesis. For example both mammalian X-chromosome inactivation and nuclear transfer (cloning) are subject to epigenetic regulation. Amongst the epigenetic mechanisms we will discuss in this course are chromatin organization, histone modification, DNA methylation and non-coding RNAs. The course is geared toward advanced undergraduate and beginning graduate students and is a combination of lectures, student presentations and research presentations by guest speakers. Students will work with the current scientific literature.

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SM 477. The Science and Art of Biotechnology. (A) Roth.Prerequisite(s): Either BIOL 202, 204, 205, or 221 or permission of the department.

Biotechnology transforms basic biological research into pharmaceutical therapies. This course will examine some explanations for American biotechnology vitality by studying case histories in which fundamental, biological observations were subsequently developed, successfully and unsuccessfully, for therapeutic applications. Along the way, we will also seek to understand the interactions among academic research institutions, biotechnology companies, large pharmaceutical companies, the Food and Drug Administration, financial institutions, venture groups, and the Patent and Trademark Office. Classes will be highly interactive. Students will present case histories in a critical fashion. Ultimately, students will conduct mock negotiations focused on university technology transfers, clinical trial design, financing, and intellectual property.

480. (CAMB480) Advanced Cell Biology. (A) Guo.Prerequisite(s): BIOL 202 or 205.

This course is designed for beginning graduate students and advanced undergraduates with a particular enthusiasm for cell biology. Biology 480 does not attempt to cover all aspects of cell biology, and is therefore not appropriate for students seeking a lecture course which provides a comprehensive survey of the field. Rather, the primary objective of this course is to teach those students considering a career in the biomedical sciences how to read, discuss, and question original research papers effectively. Intensive classroom discussions focus on the experimental methods used, results obtained, interpretation of these results in the context of cell structure and function, and implications for further studies.

SM 482. (CAMB482) Cell Signaling. (B) Gallagher.Prerequisite(s): BIOL 202 or 205 or permission of instructor.

The evolution of multicellularity required that cells be able to both send and receive signals from their neighbors. The development of organs and differentiation of cells and tissues requires reliable and continuous communication between cells. Consequences of inappropriate or anomalous signaling include development abnormalities and cancer. This class will examine mechanisms of cell-to-cell signaling between plant and animal cells with an emphasis on the cell biology of development.

SM 484. Cell Motility and the Cytoskeleton. (A) Svitkina.Prerequisite(s): BIOL 202 or 205.

Cytoskeleton and cell motility plays a crucial role in many aspects of normal and pathological physiology of individual cells, tissues, and whole organisms, including morphogenesis, immune response, wound healing, oncogenesis, and infection. This course will cover current topics in cell biology with emphasis on cytoskeleton and cell motility and their roles in these processes. Lectures, student presentations, and discussions in the class will be based on primary scientific literature.

SM 485. (CAMB485) The RNA World: A functional and computational analysis. (J) Gregory.Prerequisite(s): BIOL 221 required; BIOL 421 strongly recommended.

A focused study of genomic, biochemical, cellular, and molecular aspects of RNA. Topics of study will include RNA structure, RNA processing and turnover, splicing, ribozymes and riboswitches, RNA editing and modification, RNA interference, endogenous eukaryotic RNA silencing pathways, small RNA biology, computational methodologies for studying RNA biology, and RNA viruses. Lectures, students presentations, and discussions will be based on readings from the primary literature.

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SM 486. (CAMB486) Chromosomes and the Cell Cycle. (B) Lampson.Prerequisite(s): BIOL 202 or 205 or permission of instructor.

Life depends on the propagation of genetic material from one generation to the next through cycles of genome replication and cell division. The genome is copied by the parent, and one exact copy is inherited by each daughter cell. We will treat chromosomes as discrete entities, rather than collections of genes, that are replicated and divided with high fidelity to ensure that the genome remains stable over many generations. By reading selected primary literature covering several decades, we will build an understanding of the cell cycle by focusing on chromosomes and the associated molecular machinery. We will explore mechanisms that underlie replication and division, particularly control mechanisms that maintain genome integrity and are critical to prevent disease. The goal of the course is to develop a picture of the cell cycle by examining some of the key experiments and insights that have led to our current understanding.

488. (CAMB578, NGG 578) Advanced Topics in Behavioral Genetics. (J) Abel/Bucan.Prerequisite (s): Permission of instructor.

This course focuses on the use of genetic techniques to study the molecular and cellular bases of behavior. Particular emphasis will be given to the role of genetic approaches in understanding the biological processes underlying memory storage, circadian rhythms, and neurological and psychiatric disorders. Reverse genetic approaches utilizing gene knockout and transgenic technologies, as well as forward genetic approaches using mutagenesis and quantitative genetic techniques will be discussed.

499. Advanced Independent Study. (C) Staff.Prerequisite(s): BIOL 399 in the same laboratory as the proposed BIOL 499.

A second semester of independent study, in most cases extending the research undertaken for the BIOL 399. Apply at the Biology Academic Office, 102 Leidy Labs.

SM 493. (CAMB493) Epigenetics of Human Health and Disease. (K) Berger.Prerequisite(s): BIOL 221 required, BIOL 483 recommended.

Epigenetic alterations encompass heritable, non-genetic changes to chromatin (the polymer of DNA plus histone proteins) that influence cellular and organismal processes. This course will examine epigenetic mechanisms in directing development from the earliest stages of growth, and in maintaining normal cellular homeostasis during life. We will also explore how diverse epigenetic processes are at the heart of numerous human disease states. We will review topics ranging from an historical perspective of the discovery of epigenetic mechanisms to the use of modern technology and drug development to target epigenetic mechanisms to increase healthy lifespan and combat human disease. The course will involve a combination of didactic lectures, primary scientific literature and research lectures, and student-led presentations.

SM 522. (CAMB522) Human Evolutionary Genomics. (J) Tishkoff.Prerequisite(s): Permission of instructor.

Advanced seminar on current topics in human genomics and human evolution. Topics include the methods used for mapping and sequencing genomes; phylogenetic and population genetic analysis; and detecting variation in the human genome. This course is designed for graduate students but advanced undergraduates with a strong background in genetics are also welcome.

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L/R 527. (BIOL221, GCB 527) Genetics for Computational Biology. (C) Bonini/Gallagher/Guild.Prerequisite(s): BIOL 101 or 121. Permission of instructor required.

This course will survey the discipline of molecular genetics. Two broad areas will be considered: 1) Molecular biology: DNA replication, transcription, translation, and the regulation of gene expression in both prokaryotic and eukaryotic systems and genomics and 2) Genetics: basic Mendelian & molecular genetics.

SM 535. (PHYS535) Topics in Theory of Living Systems. (M) Kim, Goulian, Akcay, Balasubramanian, Raj, Mossel.Prerequisite(s): Permission of instructor.

The goal of this course is to discuss broad conceptual theories that address complex phenomena of living systems. Example questions include: what is the molecular architecture of information processing in cells and developing organisms? What is the functional architecture of cooperative organization from molecules in a cell to whole organism social interactions? How is complex multi-factorial information represented in organisms? The course will meet once a week and students will research relevant papers, lead discussions, and generate synopsis of group discussions. At the end of the semester, faculty and students are expected to co-author a review report of the discussed topics.

SM 537. (CIS 635, GCB 537) Advanced Computational Biology. (A) Barash and Wang.Prerequisite (s): BIOL 437 or permission of instructor.

Discussion of special research topics.

540. (CAMB541) Genetic Analysis. (M) Poethig.Prerequisite(s): BIOL 221 or permission of instructor.

The logic and methodology of genetic analysis in plants and animals. This lecture course will focus on the use of mutations to study gene function and higher order biological processes, methods for reporting and manipulating gene expression, and analysis of the genetic basis of natural variation.

575. (BIOL375) Microbial Diversity and Pathogenesis. (B) Pohlschroder.Prerequisite(s): Permission of instructor and BIOL 221 or equivalent.

Advanced version of BIOL 375: Microbial Diversity and Pathogenesis for graduate students only. Additional readings and course work as directed.

576. (BIOL376) Microbial Diversity and Pathogenesis Lab. (B) Pohlschroder and Hogan.Prerequisite(s): Permission of instructor. BIOL 575 previously or concurrently is recommended but not required.

Advanced version of BIOL 376: Microbial Diversity and Pathogenesis Lab for graduate students only. Additional readings and course work as directed.

586. (MATH586) TOPICS IN MATH BIOLOGY.

SM 607. Writing for Biologists. (A) Schmidt, P. Course open to PhD students in Biology only

The course teaches scientific writing in a workshop format, where students both produce weekly writing assignments and critique writing submitted by others. Emphasis is placed on simplicity and clarity with the goal of writing effectively to a wide audience beyond the student's immediate research area.

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SM 700. Advanced Topics in Current Biological Research. (A) Staff. Course open to PhD students in Biology only.

Integrative seminar on current biological research for first-year PhD students.