

BIOLOGY

<http://www.bio.jhu.edu>

The Department of Biology offers a broad program of undergraduate, graduate, and postgraduate study in the biological sciences. Included among the areas in which instruction and research opportunities are available are biochemistry and biophysics, cell biology, molecular biology, microbiology, developmental biology, genetics, neuroscience, and immunology.

Undergraduate Programs

The Biology Department offers two degree options for undergraduate students, a Bachelor of Arts degree for biology majors and a Bachelor of Science degree for molecular and cellular biology majors.

Teaching Opportunities

Since most biology Ph.D.'s will teach at some time during their careers, experience in teaching is considered an essential part of the Ph.D. program. The minimum teaching requirement is three contact hours a week for one year in the laboratory sections of undergraduate courses. Further teaching experience is gained through the preparation and presentation of reports in seminars and journal clubs. The department stresses organization of material and clarity of presentation.

Facilities

The lecture rooms, teaching laboratories, and research facilities of the Biology Research Complex (consisting of Seeley G. Mudd Hall and Undergraduate Teaching Laboratories) offer a thoroughly modern research facility for molecular biology.

Financial Aid

The department has fellowship funds for the support of graduate students. Awards are granted for tuition and living expenses. Laboratory fees and research expenses are paid by the department.

Programs

- Biology, Bachelor of Arts (<https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/biology/biology-bachelor-arts/>)
- Biology, Bachelor of Arts/Master of Science (<https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/biology/biology-bachelor-arts-master-science/>)
- Cellular, Molecular, Developmental Biology and Biophysics, PhD (<https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/biology/cellular-molecular-developmental-biology-biophysics-phd/>)
- Molecular & Cellular Biology, Bachelor of Science/Master of Science (<https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/biology/molecular-cellular-biology-master-science/>)
- Molecular and Cellular Biology, Bachelor of Science (<https://e-catalogue.jhu.edu/arts-sciences/full-time-residential-programs/degree-programs/biology/molecular-cellular-biology-bachelor-science/>)

For current course information and registration go to <https://sis.jhu.edu/classes/>

Courses

AS.020.108. Population Genomics: Evolution, Extinction & Disease. 1 Credit.

Population genomics is the study of the structure, function, and variability of the entire genetic complement of organisms considered on a population scale. By examining how gene variants change in structure and frequency in populations over time, we can study the process of evolution and how it contributes to biodiversity and the formation of new species; this information can be used to increase the efficacy of conservation efforts. By studying gene variants underlying diseases at the scale of populations, we can better diagnose complex polygenic diseases like cancer. This course introduces the fundamentals of population genomics and provides an overview of the subfields of evolutionary genomics, conservation genomics, and medical genomics. Area: Natural Sciences

AS.020.120. Introduction to Laboratory Research. 1 Credit.

In this program, you will be introduced to a variety of biochemical and molecular biological laboratory techniques. These will include DNA analysis by restriction enzyme mapping, amplification of DNA segments by PCR, lipid analysis by chromatography. Additionally, you will visit a variety of biological laboratories to observe actual research projects. Recommended Course Background in Chemistry and Biology is strongly recommended.

AS.020.125. Microbe Hunters- Student-sourcing Antibiotic Discovery. 3 Credits.

This is an introductory course open to all students regardless of intended major. No science background is required. This course covers concepts of biology taught through the lens of microbes and antibiotic resistance. Using environmental samples students actively engage in the hunt for novel antimicrobials. Broader concepts include the meaning of disease, how that meaning has changed over time, and the implications of widespread antibiotic resistance for society. This is a research-based project lab course in which students participate as part of an international consortium of undergraduates at other colleges. Students will isolate and characterize antibiotic-producing bacteria from the environment using modern molecular biological techniques. The course includes a lecture and two lab meetings per week. Area: Natural Sciences

AS.020.132. Medical School Intensive. 1 Credit.

Learn the basic knowledge and techniques related to surgery, internal medicine, pediatrics, emergency medicine, and biomedical science by participating in interactive lectures and labs. You and your fellow high-school students will explore new aspects of this critical field at one of the nation's leading institutions as you are taught and guided by experts in the field of medicine.

AS.020.134. Introduction to Surgery. 1 Credit.

Students will be introduced to the fundamentals of a surgical practice. Students will also acquire skills used in the assessment and treatment of surgical conditions.

AS.020.137. Phage Discovery Lab. 1 Credit.

In this small-section introductory research lab course, students are introduced to basic microbiological techniques as they isolate and characterize a bacteriophage, a virus that infects bacteria, from an environmental sample. One meeting per week. No textbook required.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;Not open to anyone who has taken AS.020.135

Area: Natural Sciences

AS.020.151. General Biology I. 3 Credits.

This course is an introduction to biology from an evolutionary, molecular and cellular perspective. Specific topics and themes include evolutionary theory, the structure and function of biological molecules, mechanisms of harvesting energy, cell division, classical genetics and gene expression.

Area: Natural Sciences

AS.020.152. General Biology II. 3 Credits.

This course builds on the concepts presented and discussed in General Biology I. The primary foci of this course will be on the diversity of life and on the anatomy, physiology, and evolution of plants and animals. There will be a special emphasis on human biology.

Prerequisite(s): AS.020.151

Area: Natural Sciences

AS.020.153. General Biology Laboratory I. 1 Credit.

This course reinforces the topics covered in AS.020.151. Students participate in a semester-long project, identifying bacteria from Homewood campus soils using molecular biology techniques. Other laboratory exercises cover aspects of evolution, genomics and biochemistry. Cross-listed with Behavioral Biology. Student must have enrolled in AS.020.151 either this term or in past terms. Students who have credit for AP Biology but take General Biology Lab I will lose four credits of AP Biology credit. Cross-listed with Behavioral Biology.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.020.151 can be taken prior to or at the same time as AS.020.153.

Area: Natural Sciences

AS.020.154. General Biology Lab II. 1 Credit.

This course reinforces the topics covered in AS.020.152. Laboratory exercises explore subjects ranging from evolution to anatomy and physiology. Students participate in a project using molecular biology techniques to determine whether specific foods are made from genetically engineered plants. Cross-listed with Behavioral Biology

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.

Area: Natural Sciences

AS.020.161. Current Events in Biology I. 1 Credit.

In this lively and collaborative course, students discuss current events and controversies in biology ranging from bioterrorism to the health of the Chesapeake Bay.

Area: Natural Sciences

AS.020.162. Current Events in Biology II. 1 Credit.

Students will discuss current events and controversies in biology, ranging from genetic engineering to nanotechnology in medicine.

Area: Natural Sciences

AS.020.303. Genetics. 3 Credits.

Presentation of the principles of heredity and variation, and their application to evolution and development; physico-chemical nature of the gene; problems of recombination; gene action.

Area: Natural Sciences

Writing Intensive

AS.020.304. Molecular Biology. 3 Credits.

This course will focus on the ways that nucleic acids direct the synthesis of nucleic acids and proteins. Emphasis will be on modern techniques to study these fundamental processes and important biological molecules. This course fulfills a core requirement for biology majors and molecular and cellular biology majors. This course does not fulfill the elective requirement for biology or molecular and cellular biology majors.

Area: Natural Sciences

AS.020.305. Biochemistry. 3 Credits.

The molecules responsible for the life processes of animals, plants, and microbes will be examined. The structures, biosynthesis, degradation, and interconversion of the major cellular constituents including carbohydrates, lipids, proteins, and nucleic acids will illustrate the similarity of the biomolecules and metabolic processes involved in diverse forms of life. Sophomores, Juniors, and Seniors Only.

Prerequisite(s): AS.030.205 OR AS.030.212 OR EN.540.202, may be taken concurrently.

Area: Natural Sciences

AS.020.306. Cell Biology. 3 Credits.

How the molecules of living systems are organized into organelles, cells, tissues, and organisms will be explored, as well as how the activities of all of these are orchestrated and regulated to produce "life"—a phenomenon greater than the sum of its parts. Considerable emphasis is placed on experimental approaches to answering these questions. Topics covered include biological membranes, cytoskeletal elements, cell locomotion, membrane and protein traffic, the nucleus, signal transduction, the cell cycle, the extracellular matrix, epithelial structure and function. Sophomores, juniors, and seniors only. Recommended Course Background: (AS.020.151 or AS.020.305) or equivalent knowledge of biomolecules or AS.020.303.

Prerequisite(s): Cell Biology restriction: students who have completed EN.540.307 may not enroll..

Area: Natural Sciences

AS.020.312. Introduction to the Human Brain. 3 Credits.

This course explores the outstanding problem of biology: how knowledge is represented in the brain. Relating insights from cognitive psychology and systems neuroscience with formal theories of learning and memory, topics include (1) anatomical and functional relations of cerebral cortex, basal ganglia, limbic system, thalamus, cerebellum, and spinal cord; (2) cortical anatomy and physiology including laminar/columnar organization, intrinsic cortical circuit, hierarchies of cortical areas; (3) activity-dependent synaptic mechanisms; (4) functional brain imaging; (5) logicist and connectist theories of cognition; and (6) relation of mental representations and natural language.

Prerequisite(s): AS.020.306 OR EN.540.307

Area: Natural Sciences

AS.020.314. The Biology of Disease. 3 Credits.

Explore the current understanding of the biology of diseases in this upper-level elective! Each week, a new faculty member will present one class in a lecture style, followed by one class in an interactive discussion style. The faculty member will describe a disease and the fundamental biology relating to that disease and discuss the current state of the field, how their research influenced understanding of the disease, and progress towards treatments. The topics will build upon the basic concepts covered in genetics, cell biology, and molecular biology, and introduce topics related to biochemistry and developmental biology. The class will discuss a wide range of diseases including vision disorders, neurodegenerative diseases, and cancer. Class assessment will be based on homework involving asking questions about the seminar, writing brief summaries of seminars and discussions, and a final project related to topics and techniques from the semester. Open to juniors and seniors.

Prerequisite(s): AS.020.303 AND AS.020.306

Area: Natural Sciences

AS.020.315. Biochemistry Project lab. 1 Credit.

This research project laboratory investigates the flow of energy through biological systems using focused examination of key cellular energy-conversion processes. Students will be introduced to the broad field of biochemistry research through computational structural analysis, directed mutation, recombinant protein production, and enzymatic analysis. Participants will be trained in biochemical laboratory techniques and expected to contribute their findings to the scientific community using formal, academic communications.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.020.305 OR AS.250.307 OR AS.250.315. These may be taken concurrently.

Area: Natural Sciences

AS.020.316. Cell Biology Lab. 1 Credit.

The Cell Biology Laboratory will use projects with the nematode *C. elegans* and mouse 3T3 cells in culture to illustrate experimental systems which are used in cell biology. Light microscopy, fluorescence microscopy, RNA interference, fluorescence-activated cell sorting, Western blotting and the culture of nematodes and cells are techniques which will be used. Because we will be using growing organisms, there will be at least one week when students will have to visit the lab the day after their section meets to complete an experiment.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;Students may have previously taken AS.020.306 prior to enrolling in AS.020.316 OR students may concurrently enroll in AS.020.306 ANDAS.020.316 OR students must have previously completed both EN.540.202 and AS EN.540.307 prior to enrolling in as.020.316.

Area: Natural Sciences

AS.020.319. Human Genome Variation. 3 Credits.

Human Genome Variate (HGV) exposes students to the power of genomics for understanding human evolutionary history, biological traits, and medical conditions. HGV incorporates basic population genetics, direct-to-consumer DNA tests, and emerging research on human populations and their ancestors. Social and ethical issues related to the use of genetic information are also discussed.

Prerequisite(s): AS.020.303

Area: Natural Sciences

AS.020.320. Cell Division Mechanisms and Regulation. 3 Credits.

This course will focus upon the molecular mechanisms that underpin the reproduction of eukaryotic cells. General topics will include chromosome duplication, mitotic spindle action, cytokinesis, meiosis, cell cycle control, damage repair and checkpoints, and aberrant regulation characteristic of cancer. Most readings will be from recent research manuscripts and review articles. Classes will consist of a mix of lectures and student oral presentations.

Prerequisite(s): AS.020.306

Area: Natural Sciences

AS.020.321. Human Genome Variation with Computational Lab. 1 Credit.

This option combines the main course and computational lab components of HGV. HGV exposes students to the power of genomic studies for understanding human evolutionary history, biological traits, and genetic conditions. HGV incorporates basic population genetics, direct-to-consumer DNA tests, and emerging research on human populations and their ancestors. What does real human genomic data look like? How are these data analyzed in practice? Supplementing the main course, the computational lab component will explore public datasets and bioinformatic tools used to analyze human genomic data to better understand how patterns in these data can be used to test hypotheses about evolution and human phenotypes.

Prerequisite(s): AS.020.303;Students who have taken AS.020.319 are not eligible to take AS.020.321.

Area: Natural Sciences

AS.020.322. Big Data & Biology: Modeling Biological Processes. 3 Credits.

This course will cover classical and contemporary models used in the mathematical analysis of large biological datasets, ranging in scale from individual genomes to the ecology of entire populations. In particular, the course will begin with genomics, (1) covering technologies for genomic sequencing and approaches for assembly, (2) describing approaches for comparing genomes and modeling genome evolution, (3) exploring the Wright-Fisher model for allele frequencies throughout a population's history, and (4) detailing computational models for functional element discovery. As time allows, the course will extend its discussion to consider agent-based modeling and population dynamics for such topics as (5) molecular dynamics, (6) locomotion, and (7) predator-prey systems. By emphasizing the mathematical concepts, assumptions, and limitations of each model (or algorithm), students will be able to generalize approaches to the analysis of a wide range of biological data. Students will actively walk through the algorithmic steps and break down the equations of many models, but no proofs or coding will be required.

Prerequisite(s): AS.020.151 AND (AS.020.152 OR AS.020.303)

Area: Natural Sciences

AS.020.323. Computation Lab: Human Genome Variation. 1 Credit.

This is a stand-alone version of the HGV computational lab. This computation lab course is offered only to students who have completed AS.020.319 (Human Genome Variation without lab). What does real human genomic data look like? How are these data analyzed in practice? Supplementing the main course, this computational lab will explore public datasets and bioinformatic tools used to analyze human genomic data to better understand how patterns in these data can be used to test hypotheses about evolution and human phenotypes.

Prerequisite(s): AS.020.319

Area: Natural Sciences

AS.020.329. Microbiology. 3 Credits.

This course explores the physiology and genetics of microorganisms within an evolutionary and ecological framework. Concepts in microbiology will be supported by molecular studies of microbial evolution and microbial communities including that of the human microbiome. Recommended Course Background: AS.020.305

Area: Natural Sciences

Writing Intensive

AS.020.331. Human Genetics. 3 Credits.

Will examine the growing impact of human genetics on the biological sciences, on law and medicine, and on our understanding of human origins. Topics include structure and evolution of human genome, genetic and physical mapping of human chromosomes, molecular genetics of inherited diseases and forensic genetics.

Prerequisite(s): AS.020.303

Area: Natural Sciences, Social and Behavioral Sciences

AS.020.337. Stem Cells & the Biology of Aging & Disease. 2 Credits.

This will be a team-taught lecture course that focuses on the properties of stem cells, their possible role in cancer (breast and prostate), stem cell aging, and the potential utilization of stem cells for therapy. Topics will include: mechanisms of stem cell renewal, stem cell potency, the impact of the stem cell niche, stem cells and the hematopoietic system, stem cells and the neural system, stem cells in the male and female gonads, induced pluripotent stem cells and cellular reprogramming, stem cell changes with aging, and ethical and policy issues in stem cell research and use. Most lectures will be research-oriented. Students will be expected to read and critically analyze current literature, with an emphasis on the experimental bases from which our current understandings derive.

Prerequisite(s): AS.020.305 (Biochemistry) or AS.020.306 (Cell Biology) or EN.580.221 (Molecules and Cells) or EN.540.307 (Cell Biology for Engineers) or permission of instructor.

Area: Natural Sciences

AS.020.340. Developmental Genetics Lab. 3 Credits.

CRISPR (clustered regularly-interspaced short palindromic repeat) is one of the greatest advances in biology in the past decade, providing researchers with the tools to precisely and affordably edit genomes and physicians a new tool to cure disease. However, the ability to edit plant and animal genomes, including human genomes, comes with significant ethical considerations. This course will utilize a hybrid classroom-laboratory approach to provide students with both a comprehensive knowledge of the CRISPR system and a deeper understanding of how gene function is studied. At the end of the semester, you will not only understand how CRISPR works, but also have a better understanding of the power of genetics to illuminate molecular mechanisms of protein function.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.020.303 can be taken prior to or during enrollment in AS.020.340.

AS.020.344. Virology. 3 Credits.

This course will cover basic principles of viral replication and pathogenesis, as well as the host response to viral infection. It will then focus on several viruses of interest, including HIV-1, Influenza, Human Papilloma Virus, and SARS-CoV-2.

Prerequisite(s): AS.020.304 OR AS.020.306

Area: Natural Sciences

AS.020.347. AIDS. 3 Credits.

AIDS is the world's deadliest infectious disease. This course will cover the biology of human immunodeficiency virus (HIV, the infectious agent that causes AIDS), the effects of HIV on the immune system, the pharmacology of the anti-viral agents that are used to suppress HIV infection, and the ongoing quest for an HIV vaccine. Because HIV drugs cannot cure HIV-infected individuals and no HIV vaccine yet exists, we will also study the long-term consequences of HIV infection including opportunistic infections, comorbid conditions, and the HIV-related cancers Kaposi's Sarcoma and AIDS-Related lymphoma. Recommended Course Background: AS.020.306

Prerequisite(s): AS.020.306

Area: Natural Sciences

AS.020.350. Introduction to Clinical Medicine. 2 Credits.

Perm. Req'd. Post-Bac Students Only

Area: Natural Sciences

AS.020.351. Cancer Biology. 3 Credits.

While the "war on cancer" has produced modest victories with respect to clinical outcomes, our knowledge of the cellular mechanisms of cancer is now vast and represents one of the most significant scientific achievements of the past 40 years. Key aspects of cancer biology will be covered with a combination of textbook and original literature readings. Topics will include cancer cell characteristics, oncogenes, tumor suppressor genes, apoptosis, metastasis and immuno-surveillance of cancer cells. Application of our knowledge to the rational treatment of cancer will also be discussed.

Prerequisite(s): Cell Biology 020.306 or permission of instructor

Area: Natural Sciences

AS.020.361. Advanced Research Lab in Cell and Molecular Biology. 3 Credits.

An intensive research laboratory course on single-molecule, live-cell imaging of chromatin and epigenetic factors designed for undergraduate students with interests in biochemistry, molecular, cellular and computational biology. The course introduces the use of advanced fluorescence microscopy to visualize the single-molecule dynamic behaviors and spatial distributions of important nuclear proteins and chromatin factors in living cells of *Saccharomyces cerevisiae* as a model for conserved epigenetic regulators in humans. Students will learn and apply imaging and computational tools to localize and track single protein molecules in real time and calculate their diffusive parameters. Students are expected to interpret and integrate data to acquire conceptual insights on chromatin functions, e.g. how chromatin proteins, enzymes, and large protein complexes are distributed in nuclear space and time. After course completion, there is a further option for post-course research in the Wu laboratory. Open to advanced sophomores or upper level students with permission of Professor Carl Wu (wuc@jhu.edu)

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.

Area: Natural Sciences

AS.020.362. Single Molecule Approaches to Biology. 3 Credits.

This course examines how recently developed single-molecule methods have enhanced our understanding of cellular processes. The ability to observe and manipulate individual biological macromolecules has revolutionized our understanding of the machines and processes that enable life. The course will provide an overview of single-molecule approaches and discuss relevant publications that exemplify how these methodologies are applied to biological problems. For each approach, key concepts will be introduced in a lecture/discussion, followed by a student-led presentation of a related publication. Recommended coursework: Physics II

Prerequisite(s): AS.020.305 OR AS.250.316

Area: Natural Sciences

AS.020.363. Developmental Biology. 3 Credits.

This class will explore the development of animals from a single fertilized egg into a fully formed organism. We will emphasize experimental methods to understand the molecular mechanisms controlling development.

Prerequisite(s): AS.020.306 AND (AS.020.330 OR AS.020.303)

Area: Natural Sciences

AS.020.364. Molecular and Cellular Mechanisms of Reproduction. 2 Credits.

This course will address current research in the cellular and molecular biology of fundamental reproductive processes. The topics covered will vary from year to year, based on current issues in the scientific literature. The focus will be on cellular and molecular mechanisms involved in the synthesis and actions of hormones, gametogenesis, fertilization, pathologies of the reproductive tracts, developmental origins of reproductive health and disease, contraception, and infertility. The emphasis will be on defining cellular and molecular mechanisms that regulate reproductive processes, identifying the hypotheses tested in scientific papers and the strengths and limitations of experimental methods used to test the hypotheses, and evaluating and integrating data described in scientific papers. Classes will consist of a mix of lectures and student oral presentations. Recommended coursework:

Reproductive Physiology

Prerequisite(s): AS.020.306

Area: Natural Sciences

AS.020.367. Primate Adaptation and Evolution. 3 Credits.

A close look at our closest relatives, the primates. Topics include: evolutionary theory, primate evolution, primate behavior and ecology, human evolution, and modern human variation.

Area: Natural Sciences

AS.020.374. Comparative Physiology. 3 Credits.

This class examines animal physiology from an evolutionary and comparative viewpoint. The goal is to examine the commonalities, as well as unique differences, in how various animal organisms address the necessary life functions. Topics will include metabolism, neural systems, respiration, muscle systems, water and salt homeostasis, thermal regulation, and reproduction

Prerequisite(s): AS.020.305

Area: Natural Sciences

AS.020.377. Comparative Physiology Lab. 1 Credit.

This course examines the physiological principles that guide animal life processes. As a complement to the Comparative Animal Physiology lecture course, this Laboratory examines fundamental physiological principles through hands-on investigations of animal physiology using zebrafish and mussel as model systems and research-grade data acquisition systems.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.020.374, students may enroll concurrently.

Area: Natural Sciences

AS.020.379. Evolution. 3 Credits.

This course takes a broad look at the impact of natural selection and other evolutionary forces on evolution. Emphasis is placed on what we can learn from genome sequences about the history of life, as well as current evolutionary pressures. Recommended Course Background: AS.020.306, AS.020.330, or permission required

Area: Natural Sciences

AS.020.382. A Biophysical View of Biology. 3 Credits.

The objective of this course is to develop in students a strong, intuitive, and physically based sense of how fundamental biological processes work—that is, the sizes, shapes, motions, interactions, and cellular functions of biological molecules. Topics will include cell and population growth, diffusion, enzyme kinetics, the qualitative and quantitative aspects of the synthesis, structure, and function of proteins and nucleic acids, least squares equation fitting, Bayesian statistics, and the fluctuation test. The biophysical constraints that dictate the form of the immune system and constraints relevant to development will be discussed.

Area: Natural Sciences

AS.020.384. Fundamentals of Drug Discovery. 3 Credits.

The creation and implementation of new approaches to the drug discovery and development process is a very active area of research. Currently, only one compound out of 5,000 that enter preclinical studies becomes a drug. Moreover, the development process is time consuming, lasting more than ten years on average. The rate of failure is extremely high. It has become evident that this field is in urgent need of revolutionary changes. This course will cover drug discovery issues ranging from the identification of hits to their optimization as drug candidates. Current as well as novel and proposed approaches aimed at accelerating discovery, potency optimization, selectivity, pharmacokinetics and other drug properties will be discussed.

Prerequisite(s): AS.020.305 AND AS.020.306

Area: Natural Sciences

AS.020.385. Epigenetics. 3 Credits.

Course description: This course emphasizes epigenetic regulatory mechanisms including DNA methylation, histone modifications, histone variants, non-coding RNA regulation, and chromatin remodeling, etc. We will discuss the broad impact of epigenetic regulation in various biological events, ranging from stem cell activity, small RNAs' and long non-coding RNAs' function, to transgenerational epigenetic inheritance and human diseases. We will mainly use recent literatures to discuss various topics. There are both students' presentation and writing components for this course. Students will be assigned a series of papers for their presentation and faculty will meet with student presenters ahead of the time to go through the presentation content.

Prerequisite(s): AS.020.303 OR AS.020.330

Area: Natural Sciences

AS.020.402. Master's Seminar: Molecular and Cellular Biology II. 3 Credits.

This is a weekly seminar designed for students enrolled in the BA/MS program. The seminar involves student presentations of research and discussion of topics of current interest in the field. BA/MS students only.
Area: Natural Sciences

AS.020.410. Teaching and Learning in Biology. 1 Credit.

This course is by instructor permission only and exclusively for students who are invited and accepted to be learning assistants for other Biology courses. The course will focus on discussing education and application of current best teaching practices to Biology classes.
Area: Natural Sciences

AS.020.441. Mentoring in General Biology. 1 Credit.

To become a mentor, students must have successfully completed AS.020.151/152, must apply using the form on the Biology Dept. website (<https://bio.jhu.edu/undergraduate/courses/>), and must be accepted by the instructors. The deadline to apply is April 15th. S/U
Area: Natural Sciences

AS.020.442. Mentoring in General Biology. 1 Credit.

This course provides students who have taken General Biology I & II the opportunity to mentor new students in General Biology I & II. Mentors collaborate with faculty on how to lead effective sessions, create study materials for students, help student teams complete team assignments, and generally help students understand difficult concepts and principles in biology. Mentors must have a firm command of the topics covered in biology and must meet with both faculty and students through the course of the semester. To become a mentor, students must have successfully completed AS.020.151/AS.020.152, must apply using the form on the Biology Department website, and must be accepted by the instructors.
Area: Natural Sciences

AS.020.503. Independent Research in Biology. 1 - 3 Credits.

Planning and conducting original laboratory investigations on biological problems, collection and analysis of data, reporting of results. Permission of full-time faculty member in Biology dept.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

AS.020.504. Independent Research in Biology. 1 - 3 Credits.

Perm. Req'd. Freshmen or Sophomores only

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

AS.020.505. Internship - Biology. 1 Credit.

An independent course of study may be pursued under the direction of an adviser on those topics not specifically listed in the form of regular courses. Consent of adviser required.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

AS.020.506. Internship - Biology. 1 Credit.

For students undertaking internships that focus on biology fields or topics. Students wishing to enroll in this course must consult with the director of undergraduate studies or their major advisor before submitting an Independent Study Request in SIS.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

AS.020.508. Literature Research in Biology. 2 Credits.

Graduating students in the Molecular and Cellular Biology major will fulfill their research credit requirement by researching a topic in the modern scientific literature and writing a review of that topic. The topics will be self-chosen by pairs of students, who will then work together with guidance from the instructor. Intended for graduating students, not those who can fulfill this requirement at a later date with in-person research.
Area: Natural Sciences

AS.020.511. Independent Study. 3 Credits.

An independent course of study may be pursued under the direction of an adviser on those topics not specifically listed in the form of regular courses. Perm. Req'd.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

AS.020.512. Independent Study. 1 - 3 Credits.

An independent course of study may be pursued under the direction of an adviser on those topics not specifically listed in the form of regular courses. Permission Required.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

AS.020.513. Research Problems. 3 Credits.

Planning and conducting original laboratory investigations on biological problems, collection and analysis of data, reporting of results. Juniors and Seniors Only. Recommended Course Background: Permission of full-time faculty member in Biology dept.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

AS.020.514. Research Problems. 1 - 3 Credits.

Perm. Req'd. Juniors and Seniors only

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

AS.020.551. Mentored Research. 9 Credits.

This courses provide BA/MS students with intensive research experience for a full academic year. Students in the program work under the direction of a research mentor on an original research project, produce a written report in the form of a thesis, and make a presentation of the work to the Biology Department. BA/MS or BS/MS candidates only.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

AS.020.553. Mentored Research. 9 Credits.

BA/MS candidates only.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

AS.020.597. Research. 3 Credits.

Planning and conducting original laboratory investigations on biological problems, collection and analysis of data, reporting of results. Permission of full-time faculty member in Biology dept.

Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration, Online Forms.

AS.020.601. Current Research in Bioscience. 1 Credit.

This course involves 30 minute sessions with each member of the training faculty. It is designed to acquaint incoming graduate students with the research topics and research philosophy of each laboratory. This should help students choose future rotations. More generally the course provides a range of perspectives on the future of specific fields and strategies for success in science. First year Biology Graduate students only

AS.020.603. Master's Seminar: Molecular & Cellular Biology I. 3 Credits.

This is a weekly seminar designed for graduate students enrolled in the B.A./M.S. and Ph.D. programs. The seminar involves student presentations of research and discussion of topics of current interest in the field. BA/MS candidates only.

Area: Natural Sciences

AS.020.605. Computational Simulation and Analysis of Protein Stability and Interactions. 2 Credits.

This course deals with the development of computer code for the simulation and non-linear least squares analysis of experimental macromolecular data including protein stability (chemical and temperature denaturation, single and multiple domain proteins); different types of binding (single site, multiple sites, independent and cooperative binding); linkage between conformational equilibrium and binding; enzyme kinetics and inhibition; kinetics of protein denaturation/aggregation. The course will use Python as the programming language. Requirements for this course include: 1) Basic Python programming skills; 2) Calculus; 3) Students must have a basic understanding of conformational equilibrium, binding equilibrium and enzyme kinetics. If not sure, please talk to the Instructor.

Area: Natural Sciences

AS.020.607. Quantitative Biology Bootcamp. 3 Credits.

Quantitative and computational methods have become essential to modern biological research. The goal of this course is to provide an introduction to basic skills that will enable students to employ these methods. Students will learn how to work in a command line shell and use software to perform analyses of large biological datasets. Students will learn basic programming using the Python language. Throughout the course students will apply the skills learned to practical analysis problems emphasizing parsing and working with biological data formats, exploratory data analysis and visualization, and numerical and statistical methods. This course is only open to first-year students in the CMDB program.

AS.020.608. Graduate Course in Optical Microscopy. 3 Credits.

An introduction to optical microscopy from basic principles to advanced techniques. The course will involve both lectures and practical experience on a number of optical microscopes available within the IIC, other core facilities and labs in the university.

Area: Natural Sciences

AS.020.612. Introduction to the Human Brain. 3 Credits.

This course explores the outstanding problem of biology; how knowledge is represented in the brain. Relating insights from cognitive psychology and systems neuroscience with formal theories of learning and memory, topics include (1) anatomical and functional relations of cerebral cortex, basal ganglia, limbic system, thalamus, cerebellum, and spinal cord; (2) cortical anatomy and physiology including laminar/columnar organization, intrinsic cortical circuit, hierarchies of cortical areas; (3) activity-dependent synaptic mechanism; (4) functional brain imaging; (5) logicist and connectist theories of cognition; and (6) relation of mental representations and natural language. Co-listed with AS.020.312.

AS.020.617. Quantitative Biology Lab 1. 3 Credits.

This computer lab is designed for first year CMDB graduate students to enhance their quantitative skills for fall core courses. This course will cover quantitative and computational analysis of biological datasets, emphasizing molecular biology. In a hands on lab setting, students will carry learn to perform essential analyses including assembly of genomes, detection of DNA methylation, analysis of transcription factor binding and motifs, detecting genome variation, measuring expression of genes, and understanding genome evolution.

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.

AS.020.618. Quantitative Biology Lab II. 2 Credits.

This computer lab is a continuation of the fall quantitative biology lab for CMDB graduate students. This semester will cover quantitative and computational modeling of selected topics from biophysics, cellular biology, and developmental biology

Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.

AS.020.619. Thesis Proposal Preparation. 1 Credit.

This is an elective course for 2nd year PhD students in the CMDB program only. The goal of the course is to help students prepare written thesis proposals. Students will also gain practical experience in peer review, with additional lectures on using their proposals to prepare applications for the NIH National Research Service Award (F31). Because of the considerable time commitment required, students may not enroll in the course without explicit approval from their thesis advisors.

AS.020.629. Microbiology. 3 Credits.

This course explores the physiology and genetics of microorganisms within an evolutionary and ecological framework. Concepts will be supported by primary literature exploring microbial evolution and microbial communities including that of the human microbiome.

AS.020.630. Human Genetics. 3 Credits.

Will examine the growing impact of human genetics on the biological sciences, on law and medicine, and on our understanding of human origins. Topics include structure and evolution of human genome, genetic and physical mapping of human chromosomes, molecular genetics of inherited diseases and forensic genetics.

Area: Natural Sciences, Social and Behavioral Sciences

AS.020.637. Genomes & Development. 3 Credits.

This course covers gametogenesis, embryogenesis, post-embryonic development, genetic analysis, developmental genetics, model developmental systems, and cell determination. Biology graduate students only except with written permission from the instructor.

AS.020.643. Graduate Virology. 3 Credits.

This course will cover basic principles of viral replication and pathogenesis, as well as the host response to viral infection. It will then focus on several viruses of interest, including HIV-1, Influenza, Human Papilloma Virus, and SARS-CoV-2.

AS.020.644. RNA. 1.5 Credits.

A graduate seminar course that will explore RNA from its beginning in the primordial RNA world to its present-day roles in gene regulation in bacteria, mammals, and viruses. Topics will include: The early RNA world, Riboswitches, Ribozymes, evolution of protein synthesis, splicing, telomerase, RNA interference, microRNAs, long non-coding RNAs, Viral non-coding RNAs, and RNA therapeutics. Biology PHD students only. MCB MS students with instructor's permission during ADD/DROP Period.

Area: Natural Sciences

AS.020.662. Single Molecule Approaches to Biology. 3 Credits.

This course examines how recently developed single-molecule methods have enhanced our understanding of cellular processes. The ability to observe and manipulate individual biological macromolecules has revolutionized our understanding of the machines and processes that enable life. The course will provide an overview of single-molecule approaches and discuss relevant publications that exemplify how these methodologies are applied to biological problems. For each approach, key concepts will be introduced in a lecture/discussion, followed by a student-led presentation of a related publication.

Area: Natural Sciences

AS.020.668. Advanced Genetics and Molecular Biology. 3 Credits.

This course examines modern concepts in genetics and molecular biology. The course focuses on the mechanisms controlling replication, recombination, transcriptional, posttranscriptional, translational, and posttranslational regulation. Lectures will have three parts: a student-led paper presentation, a discussion about the concepts surrounding atopic, and a discussion of modern techniques to experimentally probe the topic. Biology PHD students only.

AS.020.674. Quantitative Biology and Biophysics. 4 Credits.

Students will be given instruction in the concepts of physical and quantitative biology. Students will learn to simulate biological processes, identify the relationship between data and models, and will learn to fit biological data. Note: Friday classes will be held in UTL 398.

AS.020.684. Fundamentals of Drug Discovery and Development. 3 Credits.

The creation and implementation of new approaches to the drug discovery and development process is a very active area of research. Currently, only one compound out of 5,000 that enter preclinical studies becomes a drug. Moreover, the development process is time consuming, lasting more than ten years on average. The rate of failure is extremely high. It has become evident that this field is in urgent need of revolutionary changes. This course will cover drug discovery issues ranging from the identification of hits to their optimization as drug candidates. Current as well as novel and proposed approaches aimed at accelerating discovery, potency optimization, selectivity, pharmacokinetics and other drug properties will be discussed. Grad students only.

Area: Natural Sciences

AS.020.686. Advanced Cell Biology. 3 Credits.

All aspects of cell biology are reviewed and updated in this intensive course through critical evaluation and discussion of the current scientific literature. Topics include protein trafficking, membrane dynamics, cytoskeleton, signal transduction, cell cycle control, cell physiology, and the integration of these processes in neurons. Recommended Course Background: AS.020.306

AS.020.688. PhD Excels. 2 Credits.

This course provides foundational and multi-tiered training in career strategy and professional development. Through synchronous and asynchronous classes, students will learn to assess and develop the skills needed to transition into a career and align them to their strengths, values and interests. By engaging in small group discussions, experiential learning activities and networking with alumni experts, students will enhance self-knowledge and confidence to explore wider career opportunities.

AS.020.689. PhD Excels II. 2 Credits.

This is the second course in a two-part series that provides foundational and multi-tiered training in career strategy and professional development. Through synchronous and asynchronous classes, students will learn to assess and develop the skills needed to transition into a career and align them to their strengths, values and interests. By engaging in small group discussions, experiential learning activities and networking with alumni experts, students will enhance self-knowledge and confidence to explore wider career opportunities. This course provides in-depth understanding of specific career paths based on the career exploration covered in 020.688. Biology 3rd year and above students only.

Prerequisite(s): AS.020.688

AS.020.699. CMDB Responsible Conduct in Research. 1 Credit.

This course involves discussions of ethical conduct and the responsible practice of scientific research. Department signature only; restricted to graduate students in Biology PhD students only.

AS.020.801. Research – Biological Problems. 14 - 20 Credits.

Independent research for the Ph.D. dissertation. Biology Ph.D. students only

AS.020.802. Research-Biological Problems. 9 - 20 Credits.

Biology Graduate students only.

AS.020.803. Summer Graduate Research. 9 Credits.

Summer independent research for CMDB graduate students only.

AS.020.804. Teaching Practicum. 3 Credits.

PhD students will gain valuable teaching experience, working closely with their assigned faculty supervisor. Successful completion of this course counts towards the PhD teaching requirement. (2nd year grad students & 1st year GPP students) Permission required.

AS.020.823. Introduction to Biology Research. 5 Credits.

First year Biology Graduate Students only

AS.020.824. Introduction to Biology Research. 5 Credits.

First year Biology Graduate Students only

AS.020.825. Introduction to Research. 5 Credits.

Open to first year Biology graduate students only.

AS.020.826. Introduction to Biology Research. 5 Credits.

Open to first year Biology graduate students only.

Cross Listed Courses**Biochemistry and Molecular Biology****PH.120.852. Core Research Literature. 1 - 2 Credits.**

Provides a complement to the BCMB core curriculum. Student reads research papers relating to a core lecture topic. Discussions are led by a student while a faculty member from Biochemistry or MMI act as facilitator. Helps students to develop skills in reading the primary literature and provides an introduction to the experimental paradigms underlying the concepts presented in the core course.

Course location and modality is found on the JHSPH website (<https://www.jhsph.edu/courses/>).

Biology

AS.020.153. General Biology Laboratory I. 1 Credit.

This course reinforces the topics covered in AS.020.151. Students participate in a semester-long project, identifying bacteria from Homewood campus soils using molecular biology techniques. Other laboratory exercises cover aspects of evolution, genomics and biochemistry. Cross-listed with Behavioral Biology. Student must have enrolled in AS.020.151 either this term or in past terms. Students who have credit for AP Biology but take General Biology Lab I will lose four credits of AP Biology credit. Cross-listed with Behavioral Biology. **Prerequisite(s):** Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.;AS.020.151 can be taken prior to or at the same time as AS.020.153.

Area: Natural Sciences

Biophysics

AS.250.351. Reproductive Physiology. 2 Credits.

Focuses on reproductive physiology and biochemical and molecular regulation of the female and male reproductive tracts. Topics include the hypothalamus and pituitary, peptide and steroid hormone action, epididymis and male accessory sex organs, female reproductive tract, menstrual cycle, ovulation and gamete transport, fertilization and fertility enhancement, sexually transmitted diseases, and male and female contraceptive methods. Introductory lectures on each topic followed by research-oriented lectures and readings from current literature.

Area: Natural Sciences

Biostatistics

PH.140.636. Scalable Computational Bioinformatics. 4 Credits.

Introduces the computational hardware and programming model upon which analysis tools and languages are based. Introduces and uses three main languages (Python, Perl, SQL) and their underlying rationale to develop computer science concepts such as data structures, algorithms, computational complexity, regular expressions, and knowledge representation. Draws examples and exercises from high-throughput sequence analysis, proteomics and modeling of biological systems. Reinforces key concepts through lectures with live computer demonstrations, weekly readings, and programming exercises. Has students working with a High Performance Compute Cluster and the Amazon cloud.

Course location and modality is found on the JHSPH website (<https://www.jhsph.edu/courses/>).

Chemistry

AS.030.623. Molecular Synthetic Biology. 3 Credits.

Principles and methods for the design and optimization of new biological systems, from a molecular perspective. Topics include: introduction to genetic parts and modern methods for their assembly; synthesis and incorporation of nucleic acids at the level of nucleotides, genes, and genomes; design of genetic programs; library generation and screening; directed evolution and its application to create new proteins and metabolic pathways; computational design of protein and RNA using physical and bioinformatic approaches; non-canonical amino acids and genetic code expansion. This course will also feature critical evaluation of the primary literature in this fast-paced field, and practical experience with relevant software and computational tools.

Computer Science

EN.601.749. Advanced Computational Genomics: Applied Comparative Genomics. 3 Credits.

The goal of this course is to study the leading computational and quantitative approaches for comparing and analyzing genomes starting from raw sequencing data. The course will focus on human genomics and human medical applications, but the techniques will be broadly applicable across the tree of life. The topics will include genome assembly & comparative genomics, variant identification & analysis, gene expression & regulation, personal genome analysis, and cancer genomics. The grading will be based on assignments, a midterm & final exam, class presentations, and a significant class project. [Applications] Expected course background: familiarity with UNIX scripting and/or programming.

Extrdepartmental Studies

PH.550.630. Public Health Biology. 3 Credits.

Course location and modality is found on the JHSPH website (<https://www.jhsph.edu/courses/>).

PH.550.631. Biological Basis of Public Health. 3 Credits.

Discusses molecular, biochemical, cellular and immunological methodology and approaches for the mechanistic understanding, treatment and prevention of human diseases, and for understanding disease susceptibility. The focus will be on the application of biological methods and approaches to such critical issues as infectious disease, cancer, neurodegenerative disease, COPD, environmental toxicant effects on early development, and reproductive anomalies and their treatment. Course location and modality is found on the JHSPH website (<https://www.jhsph.edu/courses/>).

PH.550.855. MA Public Health Biology Thesis. 5 - 6 Credits.

Provides an opportunity for students to, in consultation with a faculty mentor from the Dept of Biochem and Molecular Bio, Environmental Health or Molecular Microbiology and Immunology, prepare a critical, scholarly paper on an agreed upon subject area.

Course location and modality is found on the JHSPH website (<https://www.jhsph.edu/courses/>).

PH.552.605. The Science of Primary Secondary and Tertiary Prevention in Population Health. 0.5 Credits.

Provides a broad understanding of the different levels of public health prevention: primary, secondary, and tertiary and discusses the impact of each level on prevention in population health. Emphasizes the role of epidemiology in prevention and control; compares and contrasts the descriptive epidemiology, natural history, and pathologic and biologic characteristics as well as factors related to their etiology. Presents the impacts of recent advances in human genomics/genetics, immunology and metabolism on prevention strategies for chronic and acute disease. Introduces basic principles, theories, and methods in the field of prevention science. Identifies public health interventions that operate at multiple ecological levels, including the community, family, and individual. Introduces the role of resilience. Discusses case studies related to the prevention of different physical, mental, behavioral and infectious disease health problems.

Course location and modality is found on the JHSPH website (<https://www.jhsph.edu/courses/>).

PH.552.606. The Critical Importance of Evidence in Advancing Public Health Knowledge. 0.5 Credits.

Emphasizes the need to establish the credibility of the evidence, based on the rigor of the methods used in generating it (e.g., type of studies, rules of causality, the nature of errors) before employing evidence to advance knowledge, practice, or policy. Discusses the bases for debate about recommendations for particular interventions that impact a population's health, how to weigh their benefits and harms, the ethics of scientific conduct, and effective communication in building evidence. Uses illustrative case examples, such as breast and prostate cancer screening, vaccines for measles and cervical cancer, nutritional sodium reductions, and the opioid epidemic.

Course location and modality is found on the JHSPH website (<https://www.jhsph.edu/courses/>).

PH.552.608. Biologic, Genetic and Infectious Bases of Human Disease. 0.5 Credits.

Focuses on the basics of cellular and molecular biology, genetics, and infectious agents. Explains concepts that link basic biology to disease and population health. Illustrates application of biologic and genetic principles to population health using case studies.

Course location and modality is found on the JHSPH website (<https://www.jhsph.edu/courses/>).

First Year Seminars**AS.001.154. FYS: Phage Hunters - Discovering novel bacteriophages. 3 Credits.**

We often think of bacteria in the context of dangerous or annoying infections. However, bacteria themselves can be infected by even smaller and more abundant entities: viruses called bacteriophages. This First-Year Seminar will combine readings and discussion of the fundamental biology of phages and their role in controlling populations of bacteria, with lab work to discover new phages from the Johns Hopkins campus. Phages identified in this class will be added to the Science Education Alliance's archive which is comprised of phages from over 100 academic institutions worldwide and is a resource for phage biologists and physicians directly involved in developing phages as a treatment for disease.

Area: Natural Sciences

AS.001.165. FYS: Biology in Deep Time. 3 Credits.

This First-Year Seminar will explore seminal ideas in macroevolutionary theory through both classic and cutting-edge studies. Topics would include the relationship between evolution and development, how fossils shape our understanding of biological systems, and the logical basis of evolutionary inference. Students will also gain an appreciation for the historical development of these ideas and their application in modern science and beyond.

Area: Natural Sciences, Social and Behavioral Sciences

AS.001.176. FYS: Microbe Hunters - Student-sourcing Antibiotic Discovery. 3 Credits.

This First-Year-Seminar covers concepts of biology taught through the lens of microbes and antibiotic resistance. Using environmental samples, students actively engage in the hunt for novel antimicrobials. Broader concepts include the meaning of disease, how that meaning has changed over time, and the implications of widespread antibiotic resistance for society. This is a research-based project lab course in which students participate as part of an international consortium of undergraduates at other colleges. Students will isolate and characterize antibiotic-producing bacteria from the environment using modern molecular biological techniques. This seminar is open to all students, regardless of major. No prior lab experience necessary.

Area: Natural Sciences

AS.001.186. FYS: Tuberculosis. 3 Credits.

In the age of Molecular Biology, DNA sequencing allows the identification of genes. Biochemical assays allow the measurement of gene expression. Reverse transcriptase and PCR are used to determine the RNA made by activated genes. These tools and others enable the study of disease organisms on the molecular level and the ways in which they attack the human body. This First-Year Seminar will introduce students to the disease tuberculosis, to human innate and adaptive immune systems, and to the molecular biology of Mycobacterium tuberculosis, an intracellular pathogen which infects humans and manipulates the human immune response to escape detection and elimination. We will explore tuberculosis by discussing excerpts from books such as *The White Plague* by Rene and Jean Dubos, *The Microbe Hunters* by Paul de Kruif, *The Aetiology of Tuberculosis* by Robert Koch, and *Fever* by John Fuller; by watching and responding to videos and, later in the course, presentations of research papers about M. tuberculosis pathogenesis and treatment; and by growing our own cultures of Mycobacterium smegmatum, M. tb's harmless relative. Millions worldwide have tuberculosis, and this seminar examines it as a case study in the measures that are being used to control the spread of an epidemic disease.

Area: Natural Sciences

Interdepartmental**AS.360.339. Planets, Life and the Universe. 3 Credits.**

This multidisciplinary course explores the origins of life, planet formation, Earth's evolution, extrasolar planets, habitable zones, life in extreme environments, the search for life in the Universe, space missions, and planetary protection. Recommended Course Background: Three upper level (300+) courses in sciences (Biophysics, Biology, Chemistry, Physics, Astronomy, Math, or Computer Science).

Prerequisite(s): Students may not register for this class if they have already received credit for AS.020.334 OR AS.020.616 OR AS.171.333 OR AS.171.699 OR AS.270.335 OR AS.360.671

Area: Natural Sciences

AS.360.671. Planets, Life and the Universe. 3 Credits.

This multidisciplinary course explores the origins of life, planet formation, Earth's evolution, extrasolar planets, habitable zones, life in extreme environments, the search for life in the Universe, space missions, and planetary protection. Recommended Course Background: Three upper level (300+) courses in sciences (Biophysics, Biology, Chemistry, Physics, Astronomy, Math, or Computer Science).

Prerequisite(s): Students may not register for this class if they have already received credit for AS.020.616 OR AS.020.334 OR AS.171.333 OR AS.171.699 OR AS.270.335 OR AS.360.339.

Area: Natural Sciences

International Health

PH.223.686. Child and Public Health in the Tropics. 4 Credits.

Introduces students to the major global causes of child mortality and the strategies and interventions to reduce child mortality. Includes specific topics: malaria, HIV, measles, pneumonia, diarrhea, neonatal disorders and nutritional deficiencies. Additional topics may include maternal mortality, eye diseases, demography and anthropometry. Focuses on and emphasizes a theme through the different lectures, with the tension and balance between horizontal approaches to child survival, such as Integrated Management of Childhood Illness (IMCI), and vertical programs such as disease eradication programs. Discusses several papers published as part of the Lancet Child Survival and Lancet Neonatal Survival series, and gain hands-on experience applying different child survival strategies using the Lives Saved Tool (LiST). Course location and modality is found on the JHSPH website (<https://www.jhsph.edu/courses/>).

PH.223.689. Biologic Basis of Vaccine Development. 3 Credits.

Course location and modality is found on the JHSPH website (<https://www.jhsph.edu/courses/>).

Molecular Microbiology and Immunology

PH.260.655. Pandemics of the 20Th Century. 1 Credit.

Provides students with an overview of protein bioinformatics including computational and experimental approaches. Introduces amino acid and protein physical properties as well as the alignment and evolution of protein sequences. Presents protein structure and methods of structure determination as well as the use of protein databases and software for visualizing proteins and generating publication quality figures. Discusses methods for secondary and tertiary protein structure prediction including homology modeling. Also covers methods for modeling small/molecule-protein interactions within the context of rational drug discovery and design. Finally, introduces students to experimental and computational aspects of mapping protein interaction networks.

Course location and modality is found on the JHSPH website (<https://www.jhsph.edu/courses/>).

PH.260.844. Causation. 3 Credits.

Acquaints students with the central concept of causation across the biomedical and public health disciplines. Discusses how cause and effect relationships govern today's research and evidence-based decision-making based on the social, physical, political, and economic determinants of health. Compares how fields and sub-disciplines in biomedicine and public health approach causation using research case examples that illustrate major morbidity and mortality-related health problems. Examines strategies to mitigate the limitations of causal inference.

Course location and modality is found on the JHSPH website (<https://www.jhsph.edu/courses/>).

Neuroscience

AS.080.301. Behavioral Assessment of Animal Models of Cognition and Neuropsychiatric Disorders. 3 Credits.

What does a rat exploring it's environment tell us about memory? How can a mouse help us better understand schizophrenia? This course will focus on procedures that are routinely used to study behavior in animal models of cognition and neuropsychiatric disorders. Topics will include motor function, emotional and motivational states, disorders such as dementia and schizophrenia, among others. Throughout the course, we will read and discuss original research articles to illustrate and compare some of the measures and results from the various procedures.

Prerequisite(s): AS.200.141 OR AS.050.105 OR AS.080.306 OR instructor permission.

Area: Social and Behavioral Sciences

AS.080.304. Neuroscience Learning and Memory. 3 Credits.

This course is an advanced survey of the scientific study of learning and memory. Different perspectives will be used to review the science of learning and memory including the cellular-molecular basis of synaptic plasticity, the functional circuitry involved in learning and memory and memory systems in the brain. The course is designed to provide a deep understanding of the issues and current debates in learning and memory research and focuses specifically on animal models of memory and memory impairment. This is an interactive lecture course with a strong emphasis on student participation.

Prerequisite(s): AS.200.141 OR AS.080.306 OR (AS.020.312 AND AS.020.306) or instructor permission.

Area: Natural Sciences

AS.080.305. Neuroscience: Cellular and Systems I. 3 Credits.

(Formerly Nervous Systems I) Neuroscience: Cellular and Systems I is a fully integrated, two-semester course that surveys the cellular and molecular biology of neurons as well as the structure and function of the nervous system. Students must register for Neuroscience: Cellular and Systems II offered in the second term. Course open to JHU undergraduates only.

Prerequisite(s): AS.050.203 OR AS.200.141 OR AS.080.105 OR AS.050.105 or instructor permission.

Area: Natural Sciences

AS.080.308. Neuroeconomics. 3 Credits.

Every day decisions often require us to weigh the costs and benefits of engaging in a particular course of action in order to obtain some expected outcome. Unfortunately, we often lack the information necessary to obtain our desired goal with complete certainty. Economists have long been interested in understanding human decision-making under these circumstances. In parallel, neuroscientists have made great strides at describing the underlying neural basis of simple decision-making. However, despite much progress in both fields, our understanding of how the brain makes decisions is incomplete. In order to strengthen and further research in both fields, the interdisciplinary field of Neuroeconomics arose. This course will survey the field of Neuroeconomics focusing on theoretical concepts developed by economists and the role these theories are playing in guiding current experimental neuroscience.

Prerequisite(s): AS.080.306 OR AS.200.141 OR AS.020.312

Area: Natural Sciences

AS.080.328. Behavioral Neuroscience Lab. 3 Credits.

Class designed to give students first-hand knowledge of the behavioral procedures and techniques used to study behavior in the field of neuroscience. Students will gain hands-on experience by carrying out some of the behavioral tasks used to assess animals under specific behavioral domains, discuss why certain aspects (i.e. genotype, environment conditions, group size, etc.) are important factors to consider when designing, planning, and carrying out such experiments, and learn the relevance of behavioral research in translational medicine.

Prerequisite(s): AS.200.141 OR AS.200.302 OR AS.080.301 OR AS.080.306 or permission by instructor.

Area: Natural Sciences

Psychological & Brain Sciences

AS.200.141. Foundations of Brain, Behavior and Cognition. 3 Credits.

A survey of neuropsychology relating the organization of behavior to the integrative action of the nervous system. Cross-listed with Behavioral Biology and Neuroscience.

Area: Natural Sciences, Social and Behavioral Sciences

AS.200.208. Animal Behavior. 3 Credits.

This course examines how and why animal behaviors are produced across the animal kingdom. Neurobiological, hormonal and developmental mechanisms and adaptive function of behaviors are examined in an evolutionary context. Behaviors include survival, acquiring food, reproduction, communication, parental care, and cooperation. Students will also learn how to develop hypotheses and predictions for scientific questions and interpret graphical results.

Prerequisite(s): AS.200.141 OR Permission of Instructor.

Area: Natural Sciences, Social and Behavioral Sciences

AS.200.334. Human Memory Psychology. 3 Credits.

This class will survey the behavioral and biological science of human memory. Historical perspectives as well as modern controversies will be discussed. Intersections with other fields such as law, education, medicine, and technology will be highlighted. The course will be a mixture of lectures and group discussions.

Area: Social and Behavioral Sciences

AS.200.344. Behavioral Endocrinology. 3 Credits.

This course examines both the evolution and mechanisms of hormonal effects on behavior across animals, including humans. Topics will include the effects of hormones on sexual differentiation, reproductive behavior, parental behavior, stress and social behavior. Additionally, this course emphasizes developing skills in hypothesis testing and critically assessing the scientific literature. Cross-listed with Behavioral Biology and Neuroscience.

Prerequisite(s): (AS.200.141 OR AS.080.306) OR (AS.020.152) or instructor's permission

Area: Natural Sciences, Social and Behavioral Sciences

For current faculty and contact information go to <http://www.bio.jhu.edu/Directory/TenuredPlusTenureTrack.aspx>