

# AS.020 (BIOLOGY)

## AS.020.115. Bioenergetics. 2 Credits.

This course is a combination of lectures, student presentations and group discussions that address fundamental principles and also contemporary issues examining the way all forms of Life on Earth are ultimately dependent on sunlight to satisfy their food and energy requirements. We examine the steps from the capture of Physical energy (photons), to the development of electrochemical potentials and finally, to their utilization by cellular organelles towards the synthesis of the chemical "currency" that fuels all biological processes (biosynthesis, cell communication, movements, etc.). Special emphasis will be on current developments in biotechnologies that utilize microbial populations to supply us with fuels and also to clean up environmental hazards. The course will also consider ways to extract lessons from Nature's successful designs and harmonious adaptations so that we, in the long run, can utilize them towards a minimization of our negative impact on the environment. Note: Freshmen and Sophomores only, with good foundations in any two of the following: Physics, Chemistry, Biology, Biophysics.

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.020.135. Project Lab: Phage Hunting. 2 Credits.

This is an introductory course open to all freshman regardless of intended major. No science background is required. This is the first semester of a year-long research-based project lab course in which students will participate in a nation-wide program in collaboration with undergraduates at other colleges. Students will isolate and characterize novel bacteriophages (viruses that infect bacteria) from the environment using modern molecular biological techniques. The course includes two lab meetings per week. Continues in the spring. Each semester provides 2 credit hours of Natural Sciences (N) distribution credits and/or counts 2 hours toward the research requirement for the Molecular and Cellular Biology degree. No textbook is required. Freshmen only.

Area: Natural Sciences

## AS.020.136. Phage Hunting II. 1 Credit.

This is an introductory course open to all freshman regardless of intended major. No science background is required. This is the second semester of a year-long research-based project lab course in which students will participate in a nation-wide program in collaboration with undergraduates at other colleges. In the spring semester, students will annotate the genome of a bacteriophage isolated and characterized by a student in AS.020.135, in preparation for submission to a database and eventual publication. Enrollment by permission of the instructor only.

**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.020.137 or permission of instructor

Area: Natural Sciences

## 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):** Not open to anyone who has taken AS.020.135; 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.020.151. 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):** AS.020.151 can be taken prior to or at the same time as AS.020.153.; 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.020.154. 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

**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. 2 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. 3 Credits.**

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.020.323. 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. 2 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

**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):** AS.020.303 can be taken prior to or during enrollment in AS.020.340.;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.020.344. 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. 2 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):** AS.020.374, students may enroll concurrently.;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.020.379. 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.020.380. Chromatin, Chromosomes and The Cell Nucleus. 3 Credits.**

The course will present analysis of the structural basis of the genome organization in a eukaryotic nucleus and the utilization of its genomic content. We start with the analysis of the fluctuations of the structure of the double helix in response to its cellular microenvironment that yield DNA structural and functional polymorphism. Next we will deal with the mechanics of DNA compaction into chromatin and the differentiation of the chromatin structure at the level of the nucleosome via histone variants and posttranslational modifications and chromatin-based epigenetics. We will next move to chromosomal territories, chromosomal imprinting and chromosome inactivation. Finally, a few lectures will focus on selected topics of special interests that bridge current basic discoveries with potential medical applications such as the nature of telomeres and telomerase-related diseases; the role of histone octamer tails in epigenetics; transcription factors and the regulated expression of the genome. Whenever possible, paradigms will be used that correlate chromatin differentiation to certain human diseases.

**Prerequisite(s):** AS.020.305 OR AS.020.306; AS.020.303 with approval of the instructor only.

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.020.401. 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.020.402. 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.020.502. Introduction Independent Study. 1 - 3 Credits.**

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

**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. 0 - 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. 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.**

**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.**

**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.**

**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.**

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.020.605. Computational Simulation and Analysis of Protein Stability and Interactions.**

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.**

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.**

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.**

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.**

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 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.**

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.**

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.**

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.**

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.**

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.**

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.**

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.**

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.**

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.**

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.020.675. Graduate Comparative Physiology.**

This course addresses the basic principles that underlie physiological processes in animals. Framed in an evolutionary context, processes ranging from respiration, circulation, neural control, movement, excretion and metabolism will be understood in terms of core principles that also apply to humans. Emphasis is placed on the physical and chemical principles underlying the comparative biology of how different animals solve physiological problems.

**AS.020.684. Fundamentals of Drug Discovery and Development.**

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.**

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.**

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. Biology 3rd year and above students only

**AS.020.689. PhD Excels II.**

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.**

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.020.753. Logic and Methods in Modern Biology.**

The purpose of this course is to gain experience in critical thinking about the logic and methods used in modern biological research. The main approach will be the critical reading, presentation, and discussion of primary research papers, and the preparation and presentation of a research proposal. It is held once a week on the NIH Bethesda campus. Grad students only.

**Prerequisite(s):** AS.020.637 AND AS.020.668 AND AS.020.674

Area: Natural Sciences

**AS.020.801. Research – Biological Problems.**

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

**AS.020.802. Research-Biological Problems.**

Biology Graduate students only.

**AS.020.803. Summer Graduate Research.**

Summer independent research for CMDB graduate students only.

**AS.020.823. Introduction to Biology Research.**

First year Biology Graduate Students only

**AS.020.824. Introduction to Biology Research.**

First year Biology Graduate Students only

**AS.020.825. Introduction to Research.**

Open to first year Biology graduate students only.

**AS.020.826. Introduction to Biology Research.**

Open to first year Biology graduate students only.