MOLECULAR BIOLOGY AND GENETICS (BIOMG)

BIOMG 1035 - Academic Support for BIOMG 1350: Cell and Developmental Biology (1 Credit)
This course reviews material presented in BIOMG 1350 and provides problem-solving strategies and additional practice with material. BIOMG 1035 support is recommended for students who want to maximize their understanding of Cell and Developmental Biology and enhance their learning skills. BIOMG 1035 is not a substitute for BIOMG 1350.
Corequisites: BIOMG 1350.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BIOMG 1290 - Personal Genomics and Medicine: Why Should You Care About What's in Your Genes (3 Credits)
Do you have allergies to milk or wheat? Curious about your family ancestry? Does a relative suffer from a genetic disease, and you wonder if you might also be at risk? How will medicine be impacted by DNA testing? How will your own future, your quality of life, your decisions regarding children be impacted? What are the ethical, legal, and social challenges we all face as this genetic technology becomes rapidly available to anyone with as little as $99 and a saliva sample? This course is not just for those interested in science, it is a topic we all need to have a basic understanding of to ensure we are prepared for what is rapidly becoming part of all of our futures. This course is suitable for life sciences majors.
Enrollment Information: Primarily for: first-year and sophomore students.
Distribution Requirements: (BIO-AG, BSC-AG, OPHLS-AG), (BIO-AS), (SCT-IL)
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:

- Demonstrate a basic knowledge of core concepts and methods in genomics, statistics, anthropology, law and social sciences, which are relevant to genetic testing for ancestry and medical inference and diagnosis.
- Discuss intelligently the ethical, legal and social implication (ELSI) challenges and debates regarding the growing use of genetics in medicine.
- Critically read, interpret, evaluate and discuss new scientific as well as ELSI findings and debates regarding personal genomics and medicine.
- Recognize the diverse views that people have concerning the application of genetic testing to their life choices and views of their own racial/ethnic/social identity, while cultivating and understanding and appreciation of them.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 1320 - Orientation Lectures in Molecular Biology and Genetics (0 Credits)
Six professors discuss their research and promising new areas for research in the future.
Enrollment Information: Enrollment preference given to: first-year, sophomore, and transfer students.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BIOMG 1350 - Introductory Biology: Cell and Developmental Biology (3 Credits)
The course introduces molecular mechanisms that underlie the organization, division, and growth of individual cells; how they organize during embryonic development to form functional tissues and organs in multicellular organisms; and how their misbehavior contributes to disease. Students seeking additional help with the material taught in BIOMG 1350 should consider the active learning supplemental class BIOMG 1035 (see course catalog for details). The learning outcomes below indicate the topics and skills that students should master upon completion of the course.
Distribution Requirements: (BIO-AG, BSC-AG, OPHLS-AG), (BIO-AS)
Last Four Terms Offered: Summer 2025, Spring 2025, Fall 2024, Summer 2024
Learning Outcomes:

- The internal organization of the cell, cellular organelles, and their main functions.
- The four major classes of macromolecules in cells.
- The diversity of structures that allow proteins to execute nearly all of a cell's myriad functions.
- The molecular basis of various cellular processes such as secretory pathway and the cell cycle.
- The signaling pathways used by cells to communicate with each other and with their environment.
- Individual cell behaviors that act to promote form and function of embryonic tissue and organs.
- How to apply concepts learned in class to interpret hypothetical experimental observations.
- How to acquire scientific information from various databases and from the primary literature.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 2800 - Lectures in Genetics and Genomics (3 Credits)
General introduction to the fundamental principles of genetics. Topics include transmission of genetic information, genetic linkage, recombination, mutations, and DNA structure and manipulation, as well as analysis of genomes in individuals and populations.
Prerequisites: one college-level introductory biology course or equivalent, or permission of the instructor.
Distribution Requirements: (BIO-AS), (BSC-AG, OPHLS-AG)
Last Four Terms Offered: Summer 2025, Spring 2025, Fall 2024, Summer 2024
Learning Outcomes:

- Describe basic principles of inheritance, gene expression, and genomic structure in the context of biological evolution.
- Apply basic principles of inheritance and gene expression to interpretations of naturally occurring and experimental biological phenomena.
- Recognize how genetics provides an experimental approach that can be used to investigate almost any aspect of biology.
- Describe how genetics is important to future progress in medical sciences.
- Use problem-solving skills employing logical thought to solve genetic problems and interpret genetic data.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 2801 - Laboratory in Genetics and Genomics (2 Credits)
General introduction to laboratory experimental genetics. Topics include gene transmission, linkage, recombination, gene structure, mutations, and manipulation.
Prerequisites: BIOMG 2800, if you have not taken BIOMG 1350, or biochemistry (BIOMG 3300, BIOMG 3320, or BIOMG 3350). Corequisite: BIOMG 2800, if BIOMG 1350 has been taken.
Enrollment Information: Not open to: first-year students in the fall semester.
Distribution Requirements: (OPHLS-AG)
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Learning Outcomes:

- Think analytically and creatively about the applications of basic principles of inheritance and molecular genetics to interpretations of naturally occurring and experimental biological phenomena.
- Gain basic laboratory skills in genetics, molecular biology, and data recording that are generally useful in biological and medical research.
- Become familiar with basic tools of bioinformatics, including genome databases, genome browsers, and programs facilitating the comparison of DNA and protein sequences.
- Develop an understanding of how the scientific method works and how analysis of raw experimental and control data is the foundation for scientific conclusions.
- Develop an understanding of real-world biological constraints on the design and execution of experiments involving live organisms.
- Synthesize an integrated view of inheritance extending from nucleotide sequences through gene expression and chromosome mechanics.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 3300 - Principles of Biochemistry, Individualized Instruction (4 Credits)
Thirteen units that cover protein structure and function, enzymes, basic metabolic pathways, DNA, RNA, protein synthesis, and an introduction to recombinant DNA techniques. No formal lectures, auto-tutorial format.
Prerequisites: one majors-level biology course and one year general chemistry and any of the following organic chemistry courses: CHEM 1570, or CHEM 3530, or CHEM 3570, or CHEM 3590, or equivalent, or permission of instructor.
Forbidden Overlaps: BIOMG 3300, BIOMG 3310, BIOMG 3330, BIOMG 3350, NS 3200
Distribution Requirements: (BIO-AS), (BSC-AG, OPHLS-AG)
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Learning Outcomes:

- After taking BIOMG 3300, students should be able to: -Discuss and describe in writing: The structure and function of biologically important macromolecules, the general catalytic and regulatory mechanisms of enzymes, the energetics, organization, and regulation of metabolic pathways, the mechanisms underlying DNA replication, DNA repair, transcription and its regulation, and translation (protein synthesis), the techniques used to study proteins, membranes, and nucleic acids.
- Think analytically and use quantitative reasoning to solve biochemical problems.
- Formulate conclusions based on the analysis of biochemical experimental results.
- Students should recognize that the advancement of knowledge is facilitated by collaboration between individuals from a wide variety of backgrounds and beliefs.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 3310 - Principles of Biochemistry: Proteins and Metabolism (3 Credits)
The chemical reactions important to biology, and the enzymes that catalyze these reactions, are discussed in an integrated format. Topics include: protein folding, enzyme catalysis, bioenergetics, and key reactions of synthesis and catabolism.
Prerequisites: one majors-level biology course, one year general chemistry, and any of the following organic chemistry courses: CHEM 1570, CHEM 3530, CHEM 3570, CHEM 3590 or equivalent, or permission of instructor.
Forbidden Overlaps: BIOMG 3300, BIOMG 3310, BIOMG 3330, BIOMG 3350, NS 3200
Distribution Requirements: (BIO-AS), (BSC-AG, OPHLS-AG)
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- In this lecture-based course, students start from fundamental principles of chemistry, physics, and mathematics as the framework for understanding biology. Homework problems every week, together with a quiz or else major exam every week, enable students to assimilate the fundamental principles while the complexity of biochemistry is being mastered systematically. Students will be able to explain how each component of biochemistry is connected to others.
- Most of the information that students are asked to master is contained in approximately 800 pages of text reading assignments, along with the course-specific 320 page Lecture Guide. In addition, students are assigned to go online to the Protein Data Bank and examine primary scientific information about protein and carbohydrate structure. Students will be able to choose any protein or small molecule whose structure has been determined, and display that molecule on a computer screen.
- Students learn to use simple but quantitative principles to understand important biological phenomena. We emphasize the interconnections of vast amounts of information, particularly in metabolism, that are the basis for how cells stay alive. Students will be able to explain principles such as protein folding, the chemiosmotic model, and enzyme kinetics using basic principles of physical chemistry.
- Students are required to communicate their understanding of lecture material every week on a quiz or more midterm and final exams. Students learn to grasp visual representations of macromolecules, especially proteins, by means of a weekly molecular graphics assignment using the freeware PyMOL. By the end of the semester, students will be able to manipulate and explain protein and carbohydrate images by use of PyMOL, and explain these in terms of biochemical principles.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 3320 - Principles of Biochemistry: Molecular Biology (2 Credits)
Comprehensive course in molecular biology that covers the structure and properties of DNA, DNA replication and repair, synthesis and processing of RNA and proteins, the regulation of gene expression, and the principles and applications of recombinant DNA technologies, genomics, and proteomics.
Prerequisites: one majors-level biology course. Prerequisite or corequisite: one course in organic chemistry, or permission of instructor.
Distribution Requirements: (OPHLS-AG)
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:

- Discuss and describe in writing: Nucleic acids (chemical composition, biological function, DNA sequence evolution, nucleic acid technologies and techniques, recombinant DNA), Genomes (composition, complexity and diversity), Sequencing (from gene fragments to whole-genomes, comparative genomics), Chromatin (genome and DNA topology, associated proteins, higher-order structures), DNA replication and recombination (mechanisms, repair, telomeres), Transcription (prokaryotic and eukaryotic; regulation), RNA (classes, processing; non-coding RNA), Translation (genetic code, mechanism, proteomics; post-translational modifications).
- Think analytically and use quantitative reasoning to solve biochemical problems.
- Formulate conclusions based on the analysis of biochemical experimental results.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 3340 - Computer Graphics and Molecular Biology (1 Credit)
Visualization of complex biomolecules using computer graphics techniques. Group presentations on current topics in molecular biology.
Prerequisites: BIOMG 3350, BIOMG 3310, BIOMG 3320 (BIOMG 3320 may be taken concurrently). Corequisite: BIOMG 3300.
Distribution Requirements: (OPHLS-AG)
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Learning Outcomes:

- Use computer graphics techniques to study protein structure.
- Discuss and/or describe in writing the function of several proteins in terms of their structures.
- Read and critically evaluate some of the primary scientific literature in structural biology.
- Research, organize, and present an advanced topic in biochemistry.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 3350 - Principles of Biochemistry: Proteins, Metabolism, and Molecular Biology (4 Credits)
Comprehensive introduction to biologically important molecules and polymers. Topics include: protein structure and function, enzyme catalysis, metabolic regulatory pathways, DNA and RNA structure, DNA replication and repair, modern DNA technologies, gene expression, and protein synthesis.
Prerequisites: one majors-level biology course and one year general chemistry, any of the following organic chemistry courses: CHEM 1570, or CHEM 3530, or CHEM 3570, or CHEM 3590, or equivalent, or permission of instructor.
Forbidden Overlaps: BIOMG 3300, BIOMG 3310, BIOMG 3330, BIOMG 3350, NS 3200
Distribution Requirements: (BIO-AS), (BSC-AG, OPHLS-AG)
Last Four Terms Offered: Summer 2025, Spring 2025, Summer 2024, Spring 2024
Learning Outcomes:

- Discuss and/or describe in writing the structure and function of biologically important macromolecules, general catalytic and regulatory mechanisms of enzymes, the energetics and organization of metabolic pathways, the mechanisms underlying gene expression (transcription), protein synthesis (translation), DNA replication, DNA repair, and DNA recombination.
- Think analytically and use quantitative reasoning to solve biochemical problems.
- Formulate conclusions based on the analysis of biochemical experimental results.
- Establish foundations to understand concurrent progresses in biology and medicine.
- Students should recognize that the advancement of sciences is contributed by collaborative work from a wide variety of backgrounds and beliefs

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 3800 - Advanced Genetics and Genomics (3 Credits)
An extension of BIOMG 2800 in which selected topics will be explored in greater depth. The course will not attempt to cover the breadth of Genetics and Genomics. Through readings, small class discussions, and problem solving, students will develop the background for understanding selected studies from the primary research literature, chiefly on model eukaryotic experimental organisms.
Prerequisites: BIOMG 2800, BIOMG 2801.
Distribution Requirements: (BIO-AS), (OPHLS-AG)
Last Four Terms Offered: Spring 2024, Spring 2023, Spring 2021, Spring 2020
Learning Outcomes:

- Explain the nature and primary effects of mutations, both randomly generated and targeted, and discuss the utility of using experimentally induced mutations (genetic variation) to illuminate biological mechanisms.
- Describe the biological mechanisms underlying targeted modification of eukaryotic genomes.
- Describe the experimental evidence revealing the many ways in which genetic variants interact.
- Interpret genetic interactions, including their limitations, and what can be learned by studying these interactions on both a limited and a large scale.
- Explain, evaluate, and effectively interpret claims, theories, and assumptions in the Biological Sciences, including those presented in the scientific literature.
- Communicate scientific arguments and ideas clearly and explicitly through writing and speech, while demonstrating a deeper working knowledge of genetics and genomics.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 3850 - Developmental Biology (3 Credits)
This course is primarily concerned with the causal basis of developmental events, mainly focusing on animal development. We will be learning how a fertilized egg becomes an animal. Topics covered will include embryonic organization, role of genes in development, inductive interactions, morphogenesis and pattern formation. Subject matter will include not only what we know about development but also how we learned it.The course is designed to introduce the principles of development at the organ, tissue, cell, and molecular level. Due to time limitations, however, it will not be possible to explore every topic. Advanced instruction in development can be obtained through the following courses: Stem Cell Biology (BIOMG 4450), Developmental Genetics (BIOMG 6870), as well as Development and Evolution (BIOMG 4610).
Prerequisites: BIOMG 2800 or permission of instructor.
Distribution Requirements: (BIO-AS), (OPHLS-AG)
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2021, Fall 2020
Learning Outcomes:

- Explain the pros and cons of the major animal model systems used in development biology, such as C. elegans, Drosophila, amphibians, fish, mouse, and human cells.
- Understand the nature of experimental research as the basis for our current understanding in developmental biology.
- Interpret results of developmental biology experiments and draw conclusions from them.
- Describe general developmental mechanisms, including terms and concepts of developmental biology (e.g., induction, autonomous specification, morphogens, differential adhesion, etc.)
- Discuss biological information that underlies ethical issues such as stem cells and human cloning.
- Read critically primary literature on a chosen topic through literature enrichment exercises.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4000 - Genomics: Technology, Data, and Applications (3 Credits)
Introduction to principles underlying the organization of genomes and the methods of studying them, emphasizing genome-wide approaches to research. Covers the application of genomics technologies and methodologies for addressing issues including gene regulation, evolution, complex systems, genetics, and gene: phenotype relationships. Landmark and timely genomics papers and other research developments will be discussed. Basic bioinformatics tools will be incorporated.
Prerequisites: Two majors-level biology courses, and one of the following: BIOMG 2800, BIOMG 3300, BIOMG 3350, BIOMG 3310 or BIOMG 3320, or permission of instructor.
Distribution Requirements: (BIO-AS), (OPHLS-AG)
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- Identify and explain genome information encoded at multiple levels including DNA sequence, chromatin structure, transcriptional and postranscriptional regulation, and the proteome.
- Develop rudimentary skills in viewing, acquiring and processing genomic data.
- Devise experiments that take advantage of genomic technologies while keeping study design and sample size in mind.
- Appraise the applications of genomic technologies in health, medicine, agriculture etc.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4310 - Frontiers in Biophysics (0.5 Credits)
Overview of current research in biophysics at Cornell by faculty from different departments across the university. Designed for undergraduates considering a career in biophysics and for graduate students interested in biophysics research opportunities at Cornell.
Last Four Terms Offered: Fall 2023, Fall 2022, Fall 2021, Fall 2020
Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4311 - Proteins: Structure, Function and Evolution (3 Credits)
Students in this course will discover the complex behavior of proteins and how they impact biology. The course is divided into three different sections. The first section is a classic protein structure-function section incorporating advanced enzyme kinetics. The second section of this course will review how proteins evolve and how this can be practically analyzed. After the course's final section, students will be able to integrate the theory behind purifying and analyzing proteins with modern spectroscopy and microscopy techniques.
Prerequisites: BIOMG 3300, or BIOMG 3350, or BIOMG 3310/BIOMG 3320 and CHEM 3570 and CHEM 3580.
Last Four Terms Offered: Fall 2024
Learning Outcomes:

- Construct a hierarchy detailing the levels of protein structure and the general theory of protein folding.
- Perform a quantitative and qualitative assessment of enzyme function, including evaluating equations defining enzyme reaction mechanisms and constructing models defining the specific steps in enzymatic reactions.
- Develop methodologies to purify and characterize proteins and enzymes that demonstrate their ability to integrate theory and practical application for single particle analysis.
- Describe methods to acquire and synthesize information related to protein sequence and structure evolution.
- Model the relationship between homologous proteins across kingdoms of life and generate phylogenetic trees.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4320 - Survey of Cell Biology (3 Credits)
Survey of a wide array of topics focusing on the general properties of eukaryotic cells. Topics include methods used for studying cells, the structure and function of the major cellular organelles, and analyses of cellular processes such as mitosis, endocytosis, cell motility, secretion, cell-to-cell communication, gene expression, and oncogenesis. Some of the material is covered in greater depth in BIOMG 4370, BIOMG 4380, BIOMG 6360, and BIOMG 6390.
Prerequisites: at least one of the following courses: BIOMG 3300, BIOMG 3330, BIOMG 3350, BIOMG 3310 and previous or concurrent enrollment in BIOMG 3320, or equivalent.
Distribution Requirements: (BIO-AS), (OPHLS-AG)
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:

- Describe the molecular function and make-up of the major organelles and structures in a eukaryotic cell, including the nucleus, the cytoskeleton, endoplasmic reticulum, Golgi, trafficking vesicles, lysozymes, mitochondria, membranes, and chromatin.
- Explain the dynamic processes that underlie vesicular trafficking, endocytosis, the expression of genes, and inter- and intra-molecular signaling; Identify key molecular players in each process.
- Name the methods used to study the above structures and processes, including molecular biology and molecular genetics, transfection of living cells, fluorescence and electron microscopy, subcellular fractionation, and detection of specific proteins using antibodies and green fluorescent protein fusions; Explain the principle of each method; Interpret results of experiments utilizing these methods.
- Explain the experimental underpinnings of the current models for processes common to all eukaryotic cells.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4380 - RNA in Biology and Medicine (3 Credits)
It is hypothesized that RNA may have been the earliest life form on earth. Nowadays RNA plays three vital roles in biology. It serves as an information carrier to guide biological processes; it adopts sophisticated 3D structures to promote recognition and catalysis; and it promotes cellular compartmentalization. Each of these properties has been exploited for therapeutics and medicine. This course explores the idea of a prehistorical RNA World, dives deep into interesting topics in the RNA biology, and explains their connection to modern medicine. Representative topics include the mechanisms of CRISPR-Cas and RNA interference and their wide-spread applications in research and medicine, ribosome as an antibiotic target, perturbing splicing to cure genetic diseases, connection between telomerase and cancer/aging, etc. Classical experiments as well as up-to-date research are covered in this class. A portion of each class is devoted to student presentations and discussion. After completing this class, students should:
Prerequisites: BIOMG 3300, or BIOMG 3350 or BIOMG 3310/BIOMG 3320 or permission of instructor.
Distribution Requirements: (BIO-AS), (OPHLS-AG)
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- Understand the chemical structure of RNA.
- Understand the structure motifs in RNA.
- Have a good understanding of the experimental and computational methods in RNA biology research.
- Understand the catalytic strategies in ribozymes.
- Understand the ligand recognition mechanism in riboswitches.
- Understand the role of RNA in important RNA-protein complexes.
- Understand the important topics in translation.
- Understand the RNA splicing/processing/editing process.
- Understand the mechanism of RNA interference in both eukaryotes and prokaryotes.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4390 - Molecular Basis of Disease (3 Credits)
This course will examine how changes in the normal expression, structure, and activity of gene products caused by genetic mutations and environmental agents lead to disease in humans and other animals. The material will focus on how proteins with modified structures and biochemical activities cause alterations in normal cellular processes, as well as the physiological consequences of these changes. Topics will be selected from hormone insensitivity syndromes, gene fusions resulting in hybrid proteins, gene amplification, gene inactivation, disruption of signaling pathways, genetic variation in non-coding transcriptional regulatory elements, and the molecular actions of environmental poisons and toxins. The methods used to identify the underlying biochemical and genetic basis of diseases, as well as possible pharmaceutical and genetic therapies for treating the diseases, will be presented.
Prerequisites: BIOMG 3300, or BIOMG 3310 and BIOMG 3320, or BIOMG 3350 and BIOMG 2800.
Distribution Requirements: (BIO-AS), (OPHLS-AG)
Last Four Terms Offered: Spring 2024, Spring 2023, Spring 2022, Spring 2021
Learning Outcomes:

- List examples of monogenic and polygenic diseases and describe how these relate to human genetic variation.
- List the genetic drivers of cancer and discuss the mechanisms by which these genes affect cell growth pathways.
- Describe the ways that non-coding genetic changes or environmental gene regulatory changes affect cellular function.
- Describe how the immune system contributes to diseases.
- Formulate experimental strategies to identify the genetic basis of an uncharacterized disease.
- Describe the involvement of specific organ systems in cancer and other disorders.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4400 - Laboratory in Biochemistry and Molecular Biology (4 Credits)
Students in this course will carry out experiments in protein biochemistry and molecular biology in an engaging laboratory environment.
The protein biochemistry projects include protein purification (salt fractionation, ion exchange chromatography, affinity chromatography, size exclusion chromatography, and immunoprecipitation), protein analysis (SDS PAGE, BN PAGE, immunoblotting, and activity assays), and determination of enzyme kinetic parameters (Vmax, KM, and kcat). The molecular biology projects include CRISPR-mediated genome editing, nucleic acid purifications (plasmid DNA and RNA), gene expression analysis (RT-PCR and splicing), agarose gel electrophoresis, restriction endonuclease digestion, PCR, DNA cloning, transformation, and DNA sequence analysis. The course is organized around interesting projects that illustrate how different techniques are uniquely suited to answer a scientific question.
Prerequisites: BIOMG 3300 or BIOMG 3350 or BIOMG 3310-BIOMG 3320 (at least one of BIOMG 3310-BIOMG 3320 completed, but one may be taken concurrently).
Enrollment Information: Priority given to: undergraduate Biology majors in Biochemistry or Molecular and Cell Biology programs of study and to graduate students with a minor in field of Biochemistry.
Distribution Requirements: (BIO-AS), (OPHLS-AG)
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Learning Outcomes:

- Plan, carry out, and interpret the results of laboratory experiments.
- Use modern laboratory techniques to purify and study proteins and to purify and work with nucleic acids.
- Understand the theoretical basis of the laboratory techniques.
- Use on-line databases to assist in data analysis.
- Create and use a laboratory notebook.
- Effectively communicate results of laboratory work, in both oral and written form.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4450 - Stem Cells and Regeneration (3 Credits)
This course will cover basic aspects of tissue morphogenesis and homeostasis with emphasis on embryonic and adult stem cell function and related clinical applications. The focus will be placed on mouse and human stem cells. The discussion will be structured around relevant research papers that allow more in-depth analysis of the material taught during lectures.
Prerequisites: BIOMG 1350, BIOMG 2800 or permission of instructor.
Learning Outcomes:

- Delineate and describe basic concepts of stem cell biology and adult tissue regeneration.
- Analyze primary data from a leading medical research field and explain its impact on translational science (from bench to bedside).
- Present and explain complex science data in a formal setting and test strategies for stimulating group discussion.
- Examine the ethical implications of stem cell research and evaluate its potential impact on society.
- Develop and propose an experimental design that demonstrates critical thinking and creativity.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4610 - Development and Evolution (3 Credits)
This course explores the molecular and genetic pathways and mechanisms that regulate animal development, and how they are modified through evolution to result in the dazzling array of forms and functions seen in the animal kingdom. The recent and exciting combining of developmental biology with evolutionary perspectives has prompted rethinking of many biological concepts. We will explore these in detail by considering the results and implications of the latest EvoDevo research.
Prerequisites: BIOEE 1780, BIOMG 2800 and BIOMG 3300, or BIOMG 3320 or BIOMG 3350.
Distribution Requirements: (BIO-AS), (OPHLS-AG)
Last Four Terms Offered: Spring 2025, Spring 2023, Spring 2021, Spring 2019
Learning Outcomes:

- Demonstrate a working knowledge of the developmental pathways that specify body form, and how they are used and integrated across organisms, including recognizing: a. where and how these developmental pathways and genes are expressed, used, re-used, and co-opted to result in diverse phenotypes across animals (and, in one lecture, plants - if time permits). b. how these pathways and their use can be integrated into a phylogenetic context. c. the underlying molecular/genetic regulatory mechanisms, and their modifications that result in developmental diversity.
- Interpret, and analyze critically, current and classic ideas, methods, results and hypotheses in EvoDevo, via readings and lecture/discussion of scientific research papers.
- Experience articulating ideas, results and concepts in EvoDevo. Specifically: (BioMG4610) Be able to articulate orally or (briefly) in writing ideas, results and concepts in EvoDevo, and integrating these, and possibly suggesting follow-up research questions. (BioMG6610) Be able to articulate ideas, results and concepts, synthesizing and presenting complete stories on EvoDevo topics, and developing research and informational questions about the material.
- Identify intellectual connections across the content of this course with information that you learned in other biology courses.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4770 - Tricks of the trade in molecular genetic research (3 Credits)
Genetic methods including CRISPR-based genome editing provide elegant tools with which to dissect the pathways that mediate cell function, the development of multicellular organisms, and other processes. This course examines these approaches, illustrated with examples showing how they have been used to address important biological problems, including time, place, and nature of gene/pathway action. We focus primarily (but not exclusively) on multicellular organisms, including fruit flies, nematodes, and mice. Lectures, class discussion, and problem sets are based on important papers in the current and classical scientific literature.
Prerequisites: Genetics & Genomics (BIOMG2800 or equivalent) and Molecular Biology (BIOMG 3300, BIOMG 3320, BIOMG 3330, BIOMG 3350, or equivalent).
Enrollment Information: Prior courses in Developmental Biology and/or Cell Biology are helpful but not required.
Distribution Requirements: (OPHLS-AG)
Learning Outcomes:

- Demonstrate a working knowledge of the logic underlying advanced genetic methods and how these methods can be used to analyze biological pathways.
- Critique and interpret scientific research papers that describe important genetic tools and the results obtained with these methods.
- Improve the ability to communicate scientific concepts both orally and/or in writing.
- Synthesize and identify intellectual connections across the content of this course with information that you learned in other biology courses.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4810 - Population Genetics (4 Credits)
Crosslisted with BIOCB 4810
Population genetics is the study of the transmission of genetic variation through time and space. This course will provide a comprehensive introduction to the fundamental concepts and methods in population genetics, with a focus on exploring how patterns of genetic variation are connected to the underlying evolutionary processes. Topics include genetic drift, mutation, coalescence theory, demography, population structure, selection, fitness, quantitative traits, selective sweeps, and adaptation at the molecular level. Emphasis is placed on the interplay between theory, computer simulations, and the analysis of genetic data from natural as well as experimental populations. We will also discuss efforts to connect genotype with phenotype and ultimately fitness. Specific case studies will include the evolution of drug resistance, genetic ancestry mapping, experimental evolution of microbes, and the genetic structure and demographic history of human populations.
Prerequisites: BIOMG 2800, BIOEE 1780, or equivalents.
Distribution Requirements: (BIO-AS), (OPHLS-AG)
Last Four Terms Offered: Fall 2023, Spring 2022, Fall 2020, Fall 2019
Learning Outcomes:

- Describe and interpret the fundamental evolutionary processes that shape patterns of genetic variation within and between populations.
- Develop simple computer simulations of fundamental evolutionary processes.
- Apply appropriate mathematical and computational analyses for inferring evolutionary parameters from population genomic data.
- Evaluate the power and limitations of inferring evolutionary parameters from population genomic data.
- Explain the application of population genetics to fields such as conservation biology, agriculture, and medicine.
- Critically assess current research findings in population genetics.
- Discuss the ethical and societal implications of population genetics research.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4870 - Human Genomics (3 Credits)
Applies fundamental concepts of transmission, population, and molecular genetics to the problem of determining the degree to which familial clustering of diseases in humans has a genetic basis. Emphasizes the role of full genome knowledge in expediting this process of gene discovery. Stresses the role of statistical inference in interpreting genomic information. Population genetics, and the central role of understanding variation in the human genome in mediating variation in disease risk, are explored in depth. Methods such as homozygosity mapping, linkage disequilibrium mapping, and admixture mapping are examined. The format is a series of lectures with classroom discussion. Assignments include a series of problem sets and a term paper.
Prerequisites: BIOMG 2800.
Distribution Requirements: (BIO-AS), (OPHLS-AG)
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- Become familiar with technologies for genome assembly, single-nucleotide polymorphism discovery, and SNP genotyping.
- Learn basic principles of population genetics as they relate to human genetic disorders segregating in a population.
- Become able to perform simple linkage analysis by LOD scoring.
- Acquire skills to solve quantitative problems in human population genetics.
- Develop understanding of how genome-wide association testing works, and its limitations.
- Learn how admixture mapping works and be able to apply it when appropriate.
- Develop an appreciation for the latest work in human origins, including Neanderthal and Denisovan Genomes.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4880 - Cancer Biology and Metabolism (3 Credits)
Cancer is a global health problem often associated with high mortality due to therapeutic resistance. Metastasis, uncontrolled growth, metabolic reprogramming and oncogenic alterations are major features of most cancers and contribute to poor survival outcome in patients. Late diagnosis, cancer disparity and limited understanding of how cancers arise are also problems. We are in a modern era of multi-omics technologies including genomics, proteomics, epigenetics, and metabolomics, which are enabling unprecedented insights into the biology of cancer. This course will provide an overview on the fundamentals of cancer biology such as cancer hallmarks, signal transduction, genetics/gene mutations, therapeutic concepts such as synthetic lethality, cancer models, research methods and data analytical tools. Further, the course will introduce metabolism and metabolomics techniques.
Prerequisites: Prerequisite or corequisite: BIOMG 2800, BIOMG 3300, BIOMG 3310, BIOMG 3320 or BIOMG 3350.
Distribution Requirements: (BIO-AS)
Last Four Terms Offered: Spring 2025, Spring 2022, Spring 2021, Spring 2020
Learning Outcomes:

- Explain the basic pathways and genes that lead to the development of cancer.
- Describe the various factors and complexity of genetic mutations in cancer.
- Be able to interpret genomic data and graphs relating to cancer mutations and cancer biology.
- Be able to read, understand, critically evaluate and summarize primary literature in cancer genetics and genomics.
- Articulate a research plan based on cancer genetics and genomics techniques and knowledge.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4940 - Special Topics in Molecular Biology and Genetics (1-4 Credits)
Last Four Terms Offered: Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4980 - Teaching Experience (1-4 Credits)
Designed to give qualified undergraduate students teaching experience through actual involvement in planning and assisting in biology courses. This experience may include supervised participation in a discussion group, assisting in a biology laboratory, assisting in field biology, or tutoring.
Prerequisites: previous enrollment in course to be taught or equivalent.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4981 - Teaching Experience in Principles of Biochemistry, Indv (1-4 Credits)
BIOMG 4981 offers training and experience for undergraduate teaching assistants in BIOMG 3300 (Introductory Biochemistry: Individualized Instruction). Teaching assistants are required to complete a weekly written assignment, attend a weekly two-hour TA training meeting and to spend six hours per week in the Biochemistry Study Center answering student questions, grading written quizzes, and administering oral quizzes. Teaching Assistants are evaluated based on the quality of written work submitted, observations at the weekly meetings and Study Center shifts, as well as on the mid-term and end-of-semester course evaluations.
Prerequisites: BIOMG 3300, or BIOMG 3350, or BIOMG 3310 and BIOMG 3320.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Learning Outcomes:

- Students will demonstrate a deeper-level understanding of the concepts in BIOMG 3300.
- Students will become skilled at creating and maintaining a comfortable working environment for diverse groups of learners.
- Students will become proficient in active listening techniques and they will learn how to tailor their questions to probe different levels of knowledge (remembering, applying, etc.).
- Students will be able to clearly and effectively articulate responses to student questions on BIOMG 3300 course concepts.
- Students will learn to grade student quizzes carefully and impartially and they will appreciate the importance of handling sensitive student quiz records ethically.
- Students will work in small groups to solve course-related problems and they will function as a team to efficiently manage a fast-paced Study Center.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 4982 - Teaching Leadership in Principles of Biochemistry, Indv (1-4 Credits)
BIOMG 4982 gives students who have successfully served as a BIOMG 3300 Teaching Assistant (as part of BIOMG 4981) a second opportunity at teaching the class and the added privilege of assisting the course instructor in leading and mentoring the incoming teaching assistant group. In addition to the required leadership responsibilities, students in BIOMG 4982 are required to review the material on a weekly basis and to spend six hours per week in the Biochemistry Study Center. Teaching Leaders are evaluated based on observations made during their Study Center shifts, as well as on the mid-term and end-of-semester course evaluations.
Prerequisites: BIOMG 4981.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Learning Outcomes:

- Students will demonstrate a deeper-level understanding of the concepts in BIOMG 3300.
- Students will become skilled at creating and maintaining a comfortable working environment for diverse groups of learners.
- Students will become proficient in active listening techniques and they will learn how to tailor their questions to probe different levels of knowledge (remembering, applying, etc.).
- Students will be able to clearly and effectively articulate responses to student questions on BIOMG 3300 course concepts.
- Students will learn to grade student quizzes carefully and impartially and they will appreciate the importance of handling sensitive student quiz records ethically.
- Students will work in small groups to solve course-related problems and they will function as a team to efficiently manage a fast-paced Study Center.
- Students will learn how to become effective leaders and mentors.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 5350 - Introductory Biology: Cell and Developmental Biology (3 Credits)
The course introduces molecular mechanisms that underlie the organization, division, and growth of individual cells; how they organize during embryonic development to form functional tissues and organs in multicellular organisms; and how their misbehavior contributes to disease. The learning outcomes below indicate the topics and skills that students should master upon completion of the course.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022
Learning Outcomes:

- The internal organization of the cell, cellular organelles and their main functions.
- The four major classes of macromolecules in cells.
- The diversity of structures that allow proteins to execute nearly all of a cell's myriad functions.
- The molecular basis of various cellular processes such as secretory pathway and the cell cycle.
- The signaling pathways used by cells to communicate with each other and with their environment.
- Individual cell behaviors that act to promote form and function of embryonic tissue and organs.
- How to apply concepts learned in class to interpret hypothetical experimental observations.
- How to acquire scientific information from various databases and from the primary literature.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6000 - Genomics: Technology, Data, and Applications (3 Credits)
Introduction to principles underlying the organization of genomes and the methods of studying them, emphasizing genome-wide approaches to research. Covers the application of genomics technologies and methodologies for addressing issues including gene regulation, evolution, complex systems, genetics, and gene: phenotype relationships. Landmark and timely genomics papers and other research developments will be discussed. Basic bioinformatics tools will be incorporated.
Prerequisites: Two majors-level biology courses, and one of the following: BIOMG 2800, BIOMG 3300, BIOMG 3350, BIOMG 3310 or BIOMG 3320, or permission of instructor.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- Identify and explain genome information encoded at multiple levels including DNA sequence, chromatin structure, transcriptional and postranscriptional regulation, and the proteome.
- Develop rudimentary skills in viewing, acquiring and processing genomic data.
- Devise experiments that take advantage of genomic technologies while keeping study design and sample size in mind.
- Appraise the applications of genomic technologies in health, medicine, agriculture etc.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6300 - Principles of Biochemistry, Individualized Instruction (4 Credits)
Thirteen units that cover protein structure and function, enzymes, basic metabolic pathways, DNA, RNA, protein synthesis, and an introduction to recombinant DNA techniques. No formal lectures, auto-tutorial format.
Prerequisites: one majors-level biology course, and one year general chemistry, and one of the following courses or their equivalents: CHEM 1570, CHEM 3530, CHEM 3570, CHEM 3590, or permission of instructor.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Learning Outcomes:

- Students will be able to discuss and describe in writing: The structure and function of biologically important macromolecules, the general catalytic and regulatory mechanisms of enzymes, the energetics, organization, and regulation of metabolic pathways, the mechanisms underlying DNA replication, DNA repair, transcription and its regulation, and translation (protein synthesis), the techniques used to study proteins, membranes, and nucleic acids.
- Students will be able to think analytically and use quantitative reasoning to solve biochemical problems.
- Students will be able to formulate conclusions based on the analysis of biochemical experimental results.
- Students will be able to recognize that the advancement of knowledge is facilitated by collaboration between individuals from a wide variety of backgrounds and beliefs.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6310 - Proteins: Structure, Function and Evolution (3 Credits)
Students in this course will discover the complex behavior of proteins and how they impact biology. The course is divided into three different sections. The first section is a classic protein structure-function section incorporating advanced enzyme kinetics. The second section of this course will review how proteins evolve and how this can be practically analyzed. After the course's final section, students will be able to integrate the theory behind purifying and analyzing proteins with modern spectroscopy and microscopy techniques.
Prerequisites: at least one of the following courses: BIOMG 3300, BIOMG 3350, BIOMG 3310/BIOMG 3320, and CHEM 3570, and CHEM 3580.
Exploratory Studies: (CU-SBY)

Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- Construct a hierarchy detailing the levels of protein structure and the general theory of protein folding.
- Perform a quantitative and qualitative assessment of enzyme function, including evaluating equations defining enzyme reaction mechanisms and constructing models defining the specific steps in enzymatic reactions.
- Develop methodologies to purify and characterize proteins and enzymes that demonstrate their ability to integrate theory and practical application for single particle analysis.
- Describe methods to acquire and synthesize information related to protein sequence and structure evolution.
- Model the relationship between homologous proteins across kingdoms of life and generate phylogenetic trees.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6311 - Principles of Biochemistry: Proteins and Metabolism (3 Credits)
The chemical reactions important to biology, and the enzymes that catalyze these reactions, are discussed in an integrated format. Topics include: protein folding, enzyme catalysis, bioenergetics, and key reactions of synthesis and catabolism.
Prerequisites: one majors-level biology course, one year general chemistry, and any of the following organic chemistry courses: CHEM 1570 ,CHEM 3530, CHEM 3570, CHEM 3590 or equivalent, or permission of instructor.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- In this lecture-based course, students start from fundamental principles of chemistry, physics, and mathematics as the framework for understanding biology. Homework problems every week, together with a quiz or else major exam every week, enable students to assimilate the fundamental principles while the complexity of biochemistry is being mastered systematically. Students will be able to explain how each component of biochemistry is connected to others.
- Most of the information that students are asked to master is contained in approximately 800 pages of text reading assignments, along with the course-specific 320 page Lecture Guide. In addition, students are assigned to go online to the Protein Data Bank and examine primary scientific information about protein and carbohydrate structure. Students will be able to choose any protein or small molecule whose structure has been determined, and display that molecule on a computer screen.
- Students learn to use simple but quantitative principles to understand important biological phenomena. We emphasize the interconnections of vast amounts of information, particularly in metabolism, that are the basis for how cells stay alive. Students will be able to explain principles such as protein folding, the chemiosmotic model, and enzyme kinetics using basic principles of physical chemistry.
- Students are required to communicate their understanding of lecture material every week on a quiz or more midterm and final exams. Students learn to grasp visual representations of macromolecules, especially proteins, by means of a weekly molecular graphics assignment using the freeware PyMOL. By the end of the semester, students will be able to manipulate and explain protein and carbohydrate images by use of PyMOL, and explain these in terms of biochemical principles.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6312 - Frontiers in Biophysics (0.5 Credits)
Overview of current research in biophysics at Cornell by faculty from different departments across the university. Designed for undergraduates considering a career in biophysics and for graduate students interested in biophysics research opportunities at Cornell.
Last Four Terms Offered: Fall 2023, Fall 2022, Fall 2021
Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6320 - Stem Cells and Regeneration (3 Credits)
This course will cover basic aspects of tissue morphogenesis and homeostasis with emphasis on embryonic and adult stem cell function and related clinical applications. The focus will be placed on mouse and human stem cells. The discussion will be structured around relevant research papers that allow more in-depth analysis of the material taught during lectures.
Prerequisites: BIOMG 1350, BIOMG 2800 or permission of instructor.
Learning Outcomes:

- Delineate and describe basic concepts of stem cell biology and adult tissue regeneration.
- Analyze primary data from a leading medical research field and explain its impact on translational science (from bench to bedside).
- Present and explain complex science data in a formal setting and test strategies for stimulating group discussion.
- Examine the ethical implications of stem cell research and evaluate its potential impact on society.
- Develop and propose an experimental design that demonstrates critical thinking and creativity.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6321 - Principles of Biochemistry: Molecular Biology (2 Credits)
Comprehensive course in molecular biology that covers the structure and properties of DNA, DNA replication and repair, synthesis and processing of RNA and proteins, the regulation of gene expression, and the principles and applications of recombinant DNA technologies, genomics, and proteomics.
Prerequisites: one majors-level biology course. Prerequisite or corequisite: one course in organic chemistry, or permission of instructor.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:

- Discuss and describe in writing: Nucleic acids (chemical composition, biological function, DNA sequence evolution, nucleic acid technologies and techniques, recombinant DNA), Genomes (composition, complexity and diversity), Sequencing (from gene fragments to whole-genomes, comparative genomics), Chromatin (genome and DNA topology, associated proteins, higher-order structures), DNA replication and recombination (mechanisms, repair, telomeres), Transcription (prokaryotic and eukaryotic; regulation), RNA (classes, processing; non-coding RNA), Translation (genetic code, mechanism, proteomics; post-translational modifications).
- Think analytically and use quantitative reasoning to solve biochemical problems.
- Formulate conclusions based on the analysis of biochemical experimental results.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6330 - DNA Biology (3 Credits)
BIOMG 6330 covers selected aspects of the molecular biology and biochemistry of DNA metabolism. Topics include DNA replication, genetic recombination, DNA repair, DNA transposition, somatic hypermutation, and DNA editing technologies. Students will become familiar with this work by reading papers that include genetic, biochemical, structural, and computational biology approaches.
Prerequisites: one of the following courses: BIOMG 3300, BIOMG 3350, BIOMG 3310/BIOMG 3320.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- Demonstrate a working knowledge of the fundamentals of DNA metabolism and how it is coordinated with other processes in the cell.
- Apply quantitative reasoning from the basic principles of physical, chemical and biochemical sciences to solve problems in the areas described in Objective 1.
- Communicate the fundamental concepts of DNA metabolism both in written and oral formats.
- Critically analyze and criticize data from journal articles, and propose additional experiments.
- Reconstruct experimental approaches by reading scientific abstracts that describe an exciting finding in DNA metabolism.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6350 - Principles of Biochemistry: Proteins, Metabolism, and Molecular Biology (4 Credits)
Comprehensive introduction to biologically important molecules and polymers. Topics include: protein structure and function, enzyme catalysis, metabolic regulatory pathways, DNA and RNA structure, DNA replication and repair, modern DNA technologies, gene expression, and protein synthesis.
Prerequisites: one majors-level biology course and one year general chemistry, any of the following organic chemistry courses: CHEM 1570, or CHEM 3530, or CHEM 3570, or CHEM 3590, or equivalent, or permission of instructor.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:

- After taking BIOMG 3350, students should be able to: Discuss and/or describe in writing: The structure and function of biologically important macromolecules, general catalytic and regulatory mechanisms of enzymes, the energetics and organization of metabolic pathways, the mechanisms underlying gene expression (transcription), protein synthesis (translation), DNA replication, DNA repair, and DNA recombination.
- Think analytically and use quantitative reasoning to solve biochemical problems.
- Formulate conclusions based on the analysis of biochemical experimental results.
- Establish foundations to understand concurrent progresses in biology and medicine.
- Students should recognize that the advancement of sciences is contributed by collaborative work from a wide variety of backgrounds and beliefs.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6360 - Functional Organization of Eukaryotic Cells (3 Credits)
This course will cover the fundamental concepts and biochemical mechanisms that contribute to the functional organization of eukaryotic cells as well as key experimental approaches in cell and molecular biology. The students are also expected to present how the major discoveries in cell biology were made and critically evaluate recent literature on cell biology.
Prerequisites: BIOMG 3300, or BIOMG 3330, or BIOMG 3350, or BIOMG 3310/BIOMG 3320, and BIOMG 4320, or equivalents.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:

- Students will formulate the fundamental concepts and biochemical mechanisms that contribute to the functional organization of eukaryotic cells. Students will be able to implement these principles to identify and address contemporary issues.
- Students will be able to describe the basic principles of key experimental approaches in cell and molecular biology and use them to address cell biological problems.
- Students will be able to implement cell biological concepts to interpret and discuss experimental data and conclusions from recent literature. Students will appraise the importance of rigor and reproducibility in cell biology research.
- Students will appraise the importance of rigor and reproducibility in cell biology research.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6380 - RNA in Biology and Medicine (3 Credits)
It is hypothesized that RNA may have been the earliest life form on earth. Nowadays RNA plays three vital roles in biology. It serves as an information carrier to guide biological processes; it adopts sophisticated 3D structures to promote recognition and catalysis; and it promotes cellular compartmentalization. Each of these properties has been exploited for therapeutics and medicine. This course explores the idea of a prehistorical RNA World, dives deep into interesting topics in the RNA biology, and explains their connection to modern medicine. Representative topics include the mechanisms of CRISPR-Cas and RNA interference and their wide-spread applications in research and medicine, ribosome as an antibiotic target, perturbing splicing to cure genetic diseases, connection between telomerase and cancer/aging, etc. Classical experiments as well as up-to-date research are covered in this class. A portion of each class is devoted to student presentations and discussion. After completing this class, students should:
Prerequisites: BIOMG 3300, or BIOMG 3350 or BIOMG 3310/BIOMG 3320 or permission of instructor.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- Understand the chemical structure of RNA.
- Understand the structure motifs in RNA.
- Have a good understanding of the experimental and computational methods in RNA biology research.
- Understand the catalytic strategies in ribozymes.
- Understand the ligand recognition mechanism in riboswitches.
- Understand the role of RNA in important RNA-protein complexes.
- Understand the important topics in translation.
- Understand the RNA splicing/processing/editing process.
- Understand the mechanism of RNA interference in both eukaryotes and prokaryotes.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6390 - The Nucleus (3 Credits)
Lectures on topics of eukaryotic genomics, chromatin structure, regulation of gene expression, RNA processing, micro-RNA regulation, the structure and movement of chromosomes, long range regulatory interactions, and nuclear export and import. Covers the structure and function of the nucleus at the molecular and cell biological levels.
Prerequisites: at least one of the following courses or their equivalent: BIOMG 3300, BIOMG 3330, BIOMG 3350, BIOMG 3310/BIOMG 3320.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:

- The students will learn how to interpret results from experiments and draw rigorous conclusions.
- The students will then be capable of proposing their own experiments to address related questions.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6391 - Molecular Basis of Disease (3 Credits)
This course will examine how changes in the normal expression, structure, and activity of gene products caused by genetic mutations and environmental agents lead to disease in humans and other animals. The material will focus on how proteins with modified structures and biochemical activities cause alterations in normal cellular processes, as well as the physiological consequences of these changes. Topics will be selected from hormone insensitivity syndromes, gene fusions resulting in hybrid proteins, gene amplification, gene inactivation, disruption of signaling pathways, genetic variation in non-coding transcriptional regulatory elements, and the molecular actions of environmental poisons and toxins. The methods used to identify the underlying biochemical and genetic basis of diseases, as well as possible pharmaceutical and genetic therapies for treating the diseases, will be presented.
Prerequisites: BIOMG 3300, or BIOMG 3310 and BIOMG 3320, or BIOMG 3350 and BIOMG 2800.
Last Four Terms Offered: Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:

- List examples of monogenic and polygenic diseases and describe how these relate to human genetic variation.
- List the genetic drivers of cancer and discuss the mechanisms by which these genes affect cell growth pathways.
- Describe the ways that non-coding genetic changes or environmental gene regulatory changes affect cellular function.
- Describe how the immune system contributes to diseases.
- Formulate experimental strategies to identify the genetic basis of an uncharacterized disease.
- Describe the involvement of specific organ systems in cancer and other disorders.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6400 - Laboratory in Biochemistry and Molecular Biology (4 Credits)
Students in this course will carry out experiments in protein biochemistry and molecular biology in an engaging laboratory environment.
The protein biochemistry projects include protein purification (salt fractionation, ion exchange chromatography, affinity chromatography, size exclusion chromatography, and immunoprecipitation), protein analysis (SDS PAGE, BN PAGE, immunoblotting, and activity assays), and determination of enzyme kinetic parameters (Vmax, KM, and kcat). The molecular biology projects include CRISPR-mediated genome editing, nucleic acid purifications (plasmid DNA and RNA), gene expression analysis (RT-PCR and splicing), agarose gel electrophoresis, restriction endonuclease digestion, PCR, DNA cloning, transformation, and DNA sequence analysis. The course is organized around interesting projects that illustrate how different techniques are uniquely suited to answer a scientific question.
Prerequisites: BIOMG 3300 or BIOMG 3350 or BIOMG 3310-BIOMG 3320 (at least one of BIOMG 3310-BIOMG 3320 completed but one may be taken concurrently).
Enrollment Information: Priority given to: undergraduate Biology majors in Biochemistry or Molecular and Cell Biology programs of study and to graduate students with a minor in field of Biochemistry.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Learning Outcomes:

- Plan, carry out, and interpret the results of laboratory experiments.
- Use modern laboratory techniques to purify and study proteins and to purify and work with nucleic acids.
- Understand the theoretical basis of the laboratory techniques.
- Use on-line databases to assist in data analysis.
- Create and use a laboratory notebook.
- Effectively communicate results of laboratory work, in both oral and written form.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6610 - Development and Evolution (3 Credits)
This course explores the molecular and genetic pathways and mechanisms that regulate animal development, and how they are modified through evolution to result in the dazzling array of forms and functions seen in the animal kingdom. The recent and exciting combining of developmental biology with evolutionary perspectives has prompted rethinking of many biological concepts. We will explore these in detail by considering the results and implications of the latest EvoDevo research.
Prerequisites: BIOEE 1780, BIOMG 2800 and BIOMG 3300, or BIOMG 3320 or BIOMG 3350.
Last Four Terms Offered: Spring 2025, Spring 2023
Learning Outcomes:

- Demonstrate a working knowledge of the developmental pathways that specify body form, and how they are used and integrated across organisms, including recognizing: a. where and how these developmental pathways and genes are expressed, used, re-used, and co-opted to result in diverse phenotypes across animals (and, in one lecture, plants - if time permits). b. how these pathways and their use can be integrated into a phylogenetic context. c. the underlying molecular/genetic regulatory mechanisms, and their modifications that result in developmental diversity.
- Interpret, and analyze critically, current and classic ideas, methods, results and hypotheses in EvoDevo, via readings and lecture/discussion of scientific research papers.
- Experience articulating ideas, results and concepts in EvoDevo. Specifically: (BioMG4610) Be able to articulate orally or (briefly) in writing ideas, results and concepts in EvoDevo, and integrating these, and possibly suggesting follow-up research questions. (BioMG6610) Be able to articulate ideas, results and concepts, synthesizing and presenting complete stories on EvoDevo topics, and developing research and informational questions about the material.
- Identify intellectual connections across the content of this course with information that you learned in other biology courses.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6810 - Population Genetics (4 Credits)
Crosslisted with BIOCB 6810
Population genetics is the study of the transmission of genetic variation through time and space. This course will provide a comprehensive introduction to the fundamental concepts and methods in population genetics, with a focus on exploring how patterns of genetic variation are connected to the underlying evolutionary processes. Topics include genetic drift, mutation, coalescence theory, demography, population structure, selection, fitness, quantitative traits, selective sweeps, and adaptation at the molecular level. Emphasis is placed on the interplay between theory, computer simulations, and the analysis of genetic data from natural as well as experimental populations. We will also discuss efforts to connect genotype with phenotype and ultimately fitness. Specific case studies will include the evolution of drug resistance, genetic ancestry mapping, experimental evolution of microbes, and the genetic structure and demographic history of human populations.
Prerequisites: BIOMG 2800, BIOEE 1780, or equivalents.
Last Four Terms Offered: Fall 2023
Learning Outcomes:

- Describe and interpret the fundamental evolutionary processes that shape patterns of genetic variation within and between populations.
- Develop simple computer simulations of fundamental evolutionary processes.
- Apply appropriate mathematical and computational analyses for inferring evolutionary parameters from population genomic data.
- Evaluate the power and limitations of inferring evolutionary parameters from population genomic data.
- Explain the application of population genetics to fields such as conservation biology, agriculture, and medicine.
- Critically assess current research findings in population genetics.
- Discuss the ethical and societal implications of population genetics research.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6850 - Developmental Biology (3 Credits)
This course is primarily concerned with the causal basis of developmental events, mainly focusing on animal development. We will be learning how a fertilized egg becomes an animal. Topics covered will include embryonic organization, role of genes in development, inductive interactions, morphogenesis and pattern formation. Subject matter will include not only what we know about development but also how we learned it. The course is designed to introduce the principles of development at the organ, tissue, cell, and molecular level. Due to time limitations, however, it will not be possible to explore every topic. Advanced instruction in development can be obtained through the following courses: Stem Cell Biology (BIOMG 4450), Developmental Genetics (BIOMG 6870), as well as Development and Evolution (BIOMG 4610).
Prerequisites: BIOMG 2800 or permission of instructor.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2021
Learning Outcomes:

- Explain the pros and cons of the major animal model systems used in development biology, such as C. elegans, Drosophila, amphibians, fish, mouse, and human cells.
- Understand the nature of experimental research as the basis for our current understanding in developmental biology.
- Interpret results of developmental biology experiments, and draw conclusions from them.
- Describe general developmental mechanisms, including terms and concepts of developmental biology (e.g., induction, autonomous specification, morphogens, differential adhesion, etc.).
- Discuss biological information that underlies ethical issues such as stem cells and human cloning.
- Read critically primary literature on a chosen topic through literature enrichment exercises.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6870 - Tricks of the trade in molecular genetic research (3 Credits)
Genetic methods including CRISPR-based genome editing provide elegant tools with which to dissect the pathways that mediate cell function, the development of multicellular organisms, and other processes. This course examines these approaches, illustrated with examples showing how they have been used to address important biological problems, including time, place, and nature of gene/pathway action. We focus primarily (but not exclusively) on multicellular organisms, including fruit flies, nematodes, and mice. Lectures, class discussion, and problem sets are based on important papers in the current and classical scientific literature.
Prerequisites: Genetics & Genomics (BIOMG2800 or equivalent) and Molecular Biology (BIOMG 3300, BIOMG 3320, BIOMG 3330, BIOMG 3350, or equivalent).
Enrollment Information: Prior courses in Developmental Biology and/or Cell Biology are helpful but not required.
Distribution Requirements: (OPHLS-AG)
Last Four Terms Offered: Spring 2024, Spring 2022, Spring 2020, Spring 2018
Learning Outcomes:

- Demonstrate a working knowledge of the logic underlying advanced genetic methods and how these methods can be used to analyze biological pathways.
- Critique and interpret scientific research papers that describe important genetic tools and the results obtained with these methods.
- Improve the ability to communicate scientific concepts both orally and/or in writing.
- Synthesize and identify intellectual connections across the content of this course with information that you learned in other biology courses.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6871 - Human Genomics (3 Credits)
Applies fundamental concepts of transmission, population, and molecular genetics to the problem of determining the degree to which familial clustering of diseases in humans has a genetic basis. Emphasizes the role of full genome knowledge in expediting this process of gene discovery. Stresses the role of statistical inference in interpreting genomic information. Population genetics, and the central role of understanding variation in the human genome in mediating variation in disease risk, are explored in depth. Methods such as homozygosity mapping, linkage disequilibrium mapping, and admixture mapping are examined. The format is a series of lectures with classroom discussion. Assignments include a series of problem sets and a term paper.
Prerequisites: BIOMG 2800.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2022, Fall 2021
Learning Outcomes:

- Become familiar with technologies for genome assembly, single-nucleotide polymorphism discovery, and SNP genotyping.
- Learn basic principles of population genetics as they relate to human genetic disorders segregating in a population.
- Become able to perform simple linkage analysis by LOD scoring.
- Acquire skills to solve quantitative problems in human population genetics.
- Develop understanding of how genome-wide association testing works, and its limitations.
- Learn how admixture mapping works and be able to apply it when appropriate.
- Develop an appreciation for the latest work in human origins, including Neanderthal and Denisovan Genomes.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6880 - Cancer Biology and Metabolism (3 Credits)
Cancer is a global health problem often associated with high mortality due to therapeutic resistance. Metastasis, uncontrolled growth, metabolic reprogramming and oncogenic alterations are major features of most cancers and contribute to poor survival outcome in patients. Late diagnosis, cancer disparity and limited understanding of how cancers arise are also problems. We are in a modern era of multi-omics technologies including genomics, proteomics, epigenetics, and metabolomics, which are enabling unprecedented insights into the biology of cancer. This course will provide an overview on the fundamentals of cancer biology such as cancer hallmarks, signal transduction, genetics/gene mutations, therapeutic concepts such as synthetic lethality, cancer models, research methods and data analytical tools. Further, the course will introduce metabolism and metabolomics techniques.
Prerequisites: Prerequisite or corequisite: BIOMG 2800, BIOMG 3300, BIOMG 3310, BIOMG 3320 or BIOMG 3350.
Last Four Terms Offered: Spring 2025, Spring 2022
Learning Outcomes:

- Explain the basic pathways and genes that lead to the development of cancer.
- Describe the various factors and complexity of genetic mutations in cancer.
- Be able to interpret genomic data and graphs relating to cancer mutations and cancer biology.
- Be able to read, understand, critically evaluate and summarize primary literature in cancer genetics and genomics.
- Articulate a research plan based on cancer genetics and genomics techniques and knowledge.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 6980 - Graduate Student Teaching Assistant Experience in Molecular Biology and Genetics (3-5 Credits)
This course is designed for graduate students in Graduate Fields of Biochemistry, Molecular and Cell Biology (BMCB) and Genetics, Genomics, and Development (GGD) who will serve as teaching assistants (TA) in undergraduate courses offered in the Department of Molecular Biology and Genetics (MBG). BMCB and GGD teaching assistants will take this course concurrently with their first TA assignment. The goal of the course is to provide teaching assistants with pedagogical skills in active learning, assessing student learning, leading discussions, grading, and best teaching practices for TA'ing MBG courses. Students will discuss their teaching experiences with their peers and gain feedback on their teaching effectiveness. An initial class meeting will help prepare students for the first day of class and provide tips for working with a teaching team. Throughout the semester, semi-weekly milestone meetings will focus on issues pertaining to graduate TAs, such as balancing research with teaching, interacting with students and course instructor, and special circumstances that may arise throughout the semester. Students will be encouraged to meet with their course instructor to gain feedback and to share their experiences with members of the course.
Enrollment Information: Enrollment limited to: graduate students.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Learning Outcomes:

- Students will be able to apply modern pedagogical methods to their teaching experience in MBG courses.
- Students will be able to apply active learning strategies and other effective teaching strategies to any MBG course where they serve as a teaching assistant.
- Students will be able to evaluate the learning of undergraduates by designing and grading various assessments.
- Students will be able to communicate effectivity through oral and written forms.
- Students will be able to interpret and apply feedback that further develops their teaching skills.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 7510 - Ethical Issues and Professional Responsibilities (1 Credit)
Ethical issues in research and the professional responsibilities of scientists are discussed based on readings and occasional lectures. The topics are intended to cover the requirements for ethical training of graduate students on training grants and follow the recommendations of the Office of Research Integrity.
Enrollment Information: Enrollment limited to: graduate students beyond first year.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BIOMG 7810 - Critical Thinking Molecular Biology and Genetics (4 Credits)
This course will combine didactic lectures with student-led presentations and critical analysis of recent literature on topical issues in molecular biology and genetics.
Enrollment Information: Enrollment limited to: first-year PhD students in field of Genetics, Genomics and Development.
Last Four Terms Offered: Spring 2025, Spring 2024, Fall 2022, Fall 2021
Learning Outcomes:

- Acquire fundamental knowledge, both conceptual and methodological, in the areas of genetics, genomics and development.
- Read critically and evaluate in depth the strengths and weaknesses of a research article, including biases in research design, implementation or interpretation.
- Identify, access, and evaluate scientific literature relevant to a specific concept or problem.
- Design and deliver an effective oral presentation with accuracy, clarity, timeliness and critical insights.
- Identify a significant methodological advance in the recent literature.
- Develop writing and illustration skills to communicate novel scientific methods.
- Transfer what students will learn in this course to their own research environment and experience.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 7860 - Research Seminar in Genetics and Development (1 Credit)
Each graduate student presents one seminar per year based on his or her thesis research. The student then meets with the thesis committee members for an evaluation of the presentation.
Enrollment Information: Requirement for and limited to: second-year and beyond graduate students in Genetics and Development.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BIOMG 7940 - Current Topics in Biochemistry, Molecular and Cell Biology (0.5-1 Credits)
Lectures and seminars on specialized topics. Topics for fall and spring to be announced in the course and time roster published at the beginning of each semester.
Prerequisites: BIOMG 3300, or BIOMG 3330, or BIOMG 3350, or BIOMG 3310/BIOMG 3320 or equivalent.
Enrollment Information: Enrollment limited to: second-year graduate students in the Field of Biochemistry, Molecular, and Cell Biology.
Last Four Terms Offered: Fall 2023, Spring 2023, Fall 2022, Spring 2022
Schedule of Classes (https://classes.cornell.edu/)

BIOMG 7941 - Preparing for the A-exam: Skills Development for Scientific Proposal Writing (1 Credit)
This seven-week course will provide graduate students in the life sciences with training in advanced science writing skills, preparing written scientific arguments, and providing constructive review of written material. At course completion, students will have completed a draft of the written portion of the A exam and will have received feedback on this draft from their classmates, senior graduate students, and postdoctoral researchers in related fields. Enrolled students are expected to be in their second year of the Ph.D. program or higher and in the process of preparing for their A-exams. We highly encourage students to have performed a thorough literature review of their research topic prior to the course beginning. This course will be focused on the writing of an A-exam proposal, so prior completion of a literature review will give students the best chance of success at completing a full proposal draft by the end of the course.
Last Four Terms Offered: Spring 2025, Spring 2024, Spring 2023, Spring 2022
Learning Outcomes:

- Describe the role of each component of an A exam proposal.
- Choose appropriate tools including figures and tables to communicate scientific ideas.
- Assemble and structure background information necessary to support a scientific argument.
- Constructively evaluate peer writing samples.
- Apply science writing skills to assemble a complete draft A exam proposal in their own words.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 8310 - Advanced Biochemical Methods I (6 Credits)
Last Four Terms Offered: Fall 2022, Fall 2021, Fall 2020, Fall 2019
Schedule of Classes (https://classes.cornell.edu/)

BIOMG 8330 - Research Seminar in Biochemistry (1 Credit)
Each student presents one seminar per year on his or her thesis research and then meets with instructors and thesis committee members for evaluation.
Enrollment Information: Requirement for and enrollment limited to: second-, third-, and fourth-year graduate students majoring in field of Biochemistry, Molecular and Cell Biology.
Last Four Terms Offered: Spring 2025, Fall 2024, Spring 2024, Fall 2023
Schedule of Classes (https://classes.cornell.edu/)

BIOMG 8369 - Foundational Skills for Graduate School and Beyond (2 Credits)
The course will focus on helping students successfully navigate the graduate experience, covering diverse topics relevant to the broader experience and realities of graduate school. Occasional guest lectures and panels will be included. Topics will include:1. Strategies and priorities in picking rotations, and selecting a thesis lab2. Work-life balance during graduate school; time-management3. Forging effective mentor-mentee relationships; selecting a thesis committee4. Navigating the scientific literature5. Scientific communication6. Scientific writing; publishing your research7. Funding and funding opportunities8. Data management9. Scientific and Research resources at Cornell10. Collaboration and Networking11. Career paths, and resources at CornellClasses will consist of lectures, discussion including breakout sessions and short format scientific presentations by students. There will be a single written assignment.
Enrollment Information: Enrollment limited to: first-year graduate students in fields of Biochemistry, Molecular and Cell Biology or Genetics, Genomics and Development.
Last Four Terms Offered: Fall 2024, Fall 2023, Fall 2020, Fall 2019
Learning Outcomes:

- Identify resources relevant to biomedical research.
- Demonstrate effective strategies for success in graduate school.
- Give scientific talks about biomedical research.

Schedule of Classes (https://classes.cornell.edu/)

BIOMG 8375 - Scientific Communication: Research Proposal Writing (1 Credit)
This is a tri-field course that is required of all second-year graduate students in the Fields of BMCB, GGD and Biophysics. The overall goal of this course is to help students develop scientific writing skills and to become familiar with the scientific peer review process, each of which will be achieved through active learning experiences. Students will learn to develop research ideas and communicate them effectively in the context of a written research proposal, using the format of an NSF Predoctoral Fellowship application.
Enrollment Information: Enrollment limited to: students enrolled in the graduate fields of Biochemistry, Molecular, and Cell Biology (BMCB), Biophysics, or Genetics, Genomics, and Development (GGD).
Last Four Terms Offered: Fall 2024
Learning Outcomes:

- Develop and assemble a research proposal.
- Justify the bigger impact and significance of their proposed research.
- Develop a research hypothesis, a set of specific aims, and enough narrative detail for a fellowship application.
- Evaluate and communicate their critique of the fellowship applications of their peers.
- Receive and process the critique of their own fellowship application.

Schedule of Classes (https://classes.cornell.edu/)