Biology (Graduate)

Associate Dean of Biology
Edward Hawrot

Associate Dean of Graduate and Postdoctoral Studies
Elizabeth O. Harrington

Graduate Biological Sciences Education

The Division of Biology and Medicine offers multiple programs of advanced graduate study leading to the degrees of A.M., Sc.M., and Ph.D. These programs are thematically based: Biotechnology; Molecular Biology, Cell Biology, and Biochemistry; Molecular Pharmacology and Physiology; Pathobiology; Ecology and Evolutionary Biology; Computational Molecular Biology; Neuroscience; and Biomedical Engineering.

The research network at Brown features advanced facilities situated on campus and at partner institutions which encourages discovery and innovation with state-of-the-art equipment and resources including: Genomics Core (http://www.brown.edu/Research/CGP/core/equipment) and Proteomics Facility (http://biomed.brown.edu/epscor_proteomics), Bioimaging facility (http://www.brown.edu/Facilities/Leduc_Bioimaging_Facility), Mouse Transgenic and Knockout Core (http://www.brown.edu/Departments/Molecular_Biology/transgenic), Animal Care Facilities (http://biomed.brown.edu/ancare), Plant Environmental Center (http://www.brown.edu/academics/ecology-and-evolutionary-biology/plant-environmental-center), Water Flume (http://www.brown.edu/Departments/EEB/research/morphology.htm), RI BioBank (http://biomed.brown.edu/rhode-island-biobank), Molecular Pathology Core (https://www.brown.edu/research/projects/superfund/cores/core-d), Computational Biology Core (https://www.brown.edu/academics/computational-molecular-biology/home). More information about the Division's Research Facilities can be found here: http://biomed.brown.edu/research/facilities.

Students entering graduate programs generally have appropriate preparatory course work as well as significant research experience. Courses are chosen with the advice of program counselors, and may include, in addition to divisional offerings, courses offered by other university departments. As a part of the doctoral training most students will be required to participate in the teaching of one or more courses related to the program.

For further information on Graduate Study in the Biological Sciences at Brown, please visit the Office of Graduate and Postdoctoral Studies website: http://biomed.brown.edu/grad-postdoc/

Biotechnology Graduate Program

The Biotechnology graduate program offers the Master of Arts (A.M.), Master of Science (Sc.M.), and Doctor of Philosophy (Ph.D.) degrees and is designed for students interested in a range of topics related to the field of biotechnology including drug & gene delivery, drug discovery, and cell therapy.

The educational objectives of the program are to promote an understanding of: 1) the designs and materials used in novel cell and drug delivery systems; 2) the molecular, cellular and animal sciences of drug discovery & drug development; and 3) the development and testing of cell-based therapies for the treatment of diseases. We also offer courses on the business and management of biotechnology. Active areas of research include: bioadhesive drug delivery systems, mesenchymal stem cells, alternatives to animal testing, nerve guidance channels, cartilage regeneration, cardiac arrhythmias, micro-vesicles, anti-microbials, insulin regulation, neuroactive & neuroprotective agents and cell delivery & encapsulation strategies.

For further information on admission and program requirements, please visit: http://www.brown.edu/academics/gradschool/programs/biomed-biotechnology-0

Ecology and Evolutionary Biology Graduate Program

The graduate program in Ecology and Evolutionary Biology is intended for highly qualified students who plan to pursue a career that includes research or teaching in ecology and/or evolutionary biology. Individual programs are designed to meet each student's needs and interests while providing a strong background in ecology, evolutionary biology and related disciplines. All students are expected to attain proficiency in ecological and evolutionary theory, quantitative research methods, statistical analysis, writing, and oral presentation. Depending on the student's interests, they may be expected to demonstrate proficiency in other areas such as functional morphology or genetics and genomics. This proficiency may be attained through coursework, seminars, independent reading, and laboratory and field programs. The Ecology and Evolutionary Biology program offers a Doctor of Philosophy (Ph.D.) degree as well as a 5th year Master of Science (Sc.M.) degree for students who would like to continue the research they started as an undergraduate at Brown. The Master of Science degree is also available for participants in Brown's Open Graduate Education Program.

For further information on admission and program requirements, please visit: http://www.brown.edu/academics/gradschool/programs/biomed-ecology-and-evolutionary-biology

Pathobiology Graduate Program

The graduate program in Pathobiology is an interdisciplinary and interdepartmental program devoted to biomedical research into the mechanisms of human diseases. The program offers a Doctor of Philosophy (Ph.D.) degree as well as a 5th year Master of Arts (A.M.) degree. The four major research and teaching thematic areas are: I) Environmental Pathology, II) Immunology & Infectious Diseases, III) Aging, and IV) Cancer biology. Training may be obtained in the areas of immunopathology, pulmonary pathology, chemical pathology, environmental and viral carcinogenesis, cancer biology, toxicologic pathology, extracellular matrix biology, hepatology, aging, and infectious diseases.

For further information on admission and program requirements, please visit: http://www.brown.edu/academics/gradschool/programs/biomed-pathobiology

Molecular Biology, Cell Biology, and Biochemistry Graduate Program

The graduate program in Molecular Biology, Cell biology, and Biochemistry (MCB) is intended for highly qualified students who plan to pursue a career which includes research in biology or medical sciences. The MCB Program offers a Doctor of Philosophy (Ph.D.) degree as well as 5th Year Master of Arts (A.M.) and Master of Science (Sc.M.) degrees. The program is interdisciplinary, focusing on molecular and cellular aspects of developmental biology, genetics, genomics and gene expression, signal transduction, oncogenesis, immunology, protein biochemistry, structural biology, proteomics, cell surface receptors, molecular modeling, DNA/RNA protein interactions, epigenetics, and virology.

For further information on admission and program requirements, please visit: http://www.brown.edu/academics/gradschool/programs/biomed-molecular-biology-cell-biology-and-biochemistry

Molecular Pharmacology and Physiology Graduate Program

The graduate program in Molecular Pharmacology and Physiology offers advanced training appropriate for academic and research careers in the fields of biology and medical sciences that include molecular and structural pharmacology; neuropharmacology, neurophysiology and neural circuit function; receptor and ion channel pharmacology and physiology; chemical biology, and signal and sensory transduction; and translational applications of pharmacology and physiology. Programs of study and
research are developed individually in consultation with the student's advisor and advisory committee and are designed to ensure expertise in the student's principal field. The Molecular Pharmacology & Physiology Program offers a Doctor of Philosophy (Ph.D.) degree, as well as a 5-Year Master of Science (Sc.M.) degree for students who would like to continue the research they started as undergraduates at Brown.

For more information on admission and program requirements, please visit: http://www.brown.edu/academics/gradschool/programs/biomedical-molecular-pharmacology-and-physiology

Biomedical Engineering Graduate Program

The Biomedical Engineering (BME) program provides cutting-edge, interdisciplinary, graduate-level education at the interface of engineering, biology, and medicine. The program features an interdisciplinary approach in three, complementary research areas: I) Mechanobiology, II) Neuroengineering, and III) Regenerative Engineering. Research in these areas is advancing the understanding of fundamental problems in engineering, biology, and medicine, while developing new therapies to improve the quality of life for people with medical problems. The program is distinguished by its quantitative rigor and strong collaborative connections among academic science, clinical medicine, and industry. The BME graduate program is designed for students with backgrounds in engineering, physics, or applied mathematics that seek additional education and training in the biological sciences.

The Biomedical Engineering program offers both the Master of Science (Sc.M) degree and the Doctor of Philosophy (Ph.D) degree.

For more information on admission and program requirements, please visit: http://www.brown.edu/academics/gradschool/programs/biomedical-engineering

Courses

**BIOL 2000B. Topics in MCDB: How Protein Structure Informs Biological Function.**
This course covers various aspects of structural and functional biology from primary to quaternary structure and deals with the 3D structure of proteins and nucleic acids and 3D structure determination. Course will be a mixture of lecture and class discussion/presentations. Students typically have taken an advanced undergraduate-level course in biology or biochemistry. Advanced undergraduates with permission. Enrollment limited to 20 students.

**BIOL 2000C. Protein Biophysics and Structure: Molecular Basis of Disease.**
Proteins are the engines of life. Determining how they function from a biophysical and structural perspective enables us to understand how they work and, equally important, how we can direct and alter their activities. These types of efforts are the basis of all medicinal and drug research. Students will obtain a broad and firm foundation of both biophysical methods and in depth studies of medicinally important proteins and protein complexes that will allow them to correlate structure and biological function. Graduate course; open to junior and senior undergraduates with permission. Instructor permission required; enrollment limited to 12 students.

**BIOL 2000D. Current Topics in Molecular, Cellular, Developmental Biology Biochemistry.**
Protein synthesis is a fundamental cellular process mediated by ribosomes. This course will focus on progress in understanding: ribosome structure and function, ribosome biogenesis and export, quality control, ribosome degradation, and interface of ribosomes with other cellular pathways. Students will present research publications on a given topic and lead a discussion examining the experimental approach and findings of each publication. Enrollment limited to 20. Intended for graduates and advanced undergraduates with instructor permission.

**BIOL 2000E. Topics in MCDB: The Genomics Revolution and its Impact on Genetics, Medicine and Society.**
A technological revolution in genomics has exponentially increased our ability to gather biological data. A host of new methods and types of analysis has arisen to accommodate this dramatic shift in data collection. The broad scope of inquiry has ushered in an era of “system-wide” approaches and brute-force strategies where rare signals can be detected and studied. In this seminar we will cover papers that embody this new approach. Enrollment limited to 20 graduate students. Advanced undergraduates with appropriate course preparation and permission from instructor.

**BIOL 2010. Quantitative Approaches to Biology.**
Graduate level introduction to quantitative and computational methods in modern biology. Topics include Programming, Modeling, Algorithms, Bioinformatics, Applied Statistics, Structural Biology, Molecular Dynamics, Enzyme Kinetics, and Population and Quantitative Human Genetics. Preference is given to graduate students in Molecular Biology, Cell Biology and Biochemistry and Molecular Pharmacology, Physiology, and Biotechnology. Limited to 20 students. Instructor permission required.

**BIOL 2018. Management Strategies in Biotechnology.**
This course, taken the second semester, goes in depth into the numerous strategies in biotechnology. Significant differences in the strategies of small companies versus large companies, and device companies versus drug companies will be discussed with ample use of biotechnology case studies. At the end of this course, the successful student will: Understand the process of managerial decision making in the pharma/biotech industry
Understand the basic principles of Decision Science, the application of quantitative analysis (modeling) to inform managerial decision making
Gain exposure to basic frameworks and tools used by management consultants to define strategic options

**BIOL 2020. Biotechnology Science and Industry.**
This course provides a comprehensive overview of the primary functional roles and steps involved in developing and commercializing a novel technology/scientific breakthrough within the biotechnology industry. This course is particularly suitable for students interested in pursuing a career within a biotechnology company, or for those interested in developing an in-depth knowledge of how the science of biotechnology becomes real world products. Pre Requisites: Foundations of Living Systems (BIOL0020), Principles of Physiology (BIOL0080), and Principles of Economics (ECON0110)/equivalent or instructor's permission is required.

**BIOL 2030. Foundations for Advanced Study in the Life Sciences.**
A double-credit graduate course on multidisciplinary experimental approaches to biological questions. Focusing on primary literature, lectures and discussions cover the mechanisms and regulation of basic cellular processes involving nucleic acids (synthesis, structure, maintenance and transmission) and proteins (synthesis, maturation, function) and their integration into more complex circuits (signaling, organelle biogenesis and inheritance, cell cycle control). Required for PhD students in the MCB Graduate Program; all others must obtain instructor permission. Enrollment is limited to graduate students.

**BIOL 2040. Ultrastructure/Bioimaging.**
This course examines microscopy and image analysis in the life sciences. Theoretical and practical aspects of microscopy will be discussed. Students will obtain hands-on experience with electron microscopy, light microscopy, fluorescence microscopy, and confocal microscopy. Students will learn to display images in 3D. For graduate students and advanced undergraduates. Instructor permission required.

**BIOL 2050. Biology of the Eukaryotic Cell.**
(Undergraduate students should register for BIOL 1050.)

**BIOL 2070. Genetics.**
Course covers various aspects of structural and functional biology from primary to quaternary structure and deals with the 3D structure of proteins and nucleic acids and 3D structure determination. Course will be a mixture of lecture and class discussion/presentations. Students typically have taken an advanced undergraduate-level course in biology or biochemistry. Advanced undergraduates with permission. Enrollment limited to 20 students.

**BIOL 2080. Bioinformatics, Applied Statistics, Structural Biology, Molecular Dynamics, Enzyme Kinetics, and Population and Quantitative Human Genetics.**
Preference is given to graduate students in Molecular Biology, Cell Biology and Biochemistry and Molecular Pharmacology, Physiology, and Biotechnology. Limited to 20 students. Instructor permission required.

**BIOL 2018. Management Strategies in Biotechnology.**
This course, taken the second semester, goes in depth into the numerous strategies in biotechnology. Significant differences in the strategies of small companies versus large companies, and device companies versus drug companies will be discussed with ample use of biotechnology case studies. At the end of this course, the successful student will: Understand the process of managerial decision making in the pharma/biotech industry
Understand the basic principles of Decision Science, the application of quantitative analysis (modeling) to inform managerial decision making
Gain exposure to basic frameworks and tools used by management consultants to define strategic options

**BIOL 2020. Biotechnology Science and Industry.**
This course provides a comprehensive overview of the primary functional roles and steps involved in developing and commercializing a novel technology/scientific breakthrough within the biotechnology industry. This course is particularly suitable for students interested in pursuing a career within a biotechnology company, or for those interested in developing an in-depth knowledge of how the science of biotechnology becomes real world products. Pre Requisites: Foundations of Living Systems (BIOL0020), Principles of Physiology (BIOL0080), and Principles of Economics (ECON0110)/equivalent or instructor's permission is required.

**BIOL 2030. Foundations for Advanced Study in the Life Sciences.**
A double-credit graduate course on multidisciplinary experimental approaches to biological questions. Focusing on primary literature, lectures and discussions cover the mechanisms and regulation of basic cellular processes involving nucleic acids (synthesis, structure, maintenance and transmission) and proteins (synthesis, maturation, function) and their integration into more complex circuits (signaling, organelle biogenesis and inheritance, cell cycle control). Required for PhD students in the MCB Graduate Program; all others must obtain instructor permission. Enrollment is limited to graduate students.

**BIOL 2040. Ultrastructure/Bioimaging.**
This course examines microscopy and image analysis in the life sciences. Theoretical and practical aspects of microscopy will be discussed. Students will obtain hands-on experience with electron microscopy, light microscopy, fluorescence microscopy, and confocal microscopy. Students will learn to display images in 3D. For graduate students and advanced undergraduates. Instructor permission required.

**BIOL 2050. Biology of the Eukaryotic Cell.**
(Undergraduate students should register for BIOL 1050.)
BIOL 2089. The Importance of Intellectual Property in Biotechnology. This course delves into the various roles of intellectual property in biotechnology. In addition to providing a solid foundation in the fundamentals of intellectual property, the course will use case studies in biotechnology to explore in depth the interplay between specific scientific breakthroughs and intellectual property. An understanding of the science of biotechnology is critical for advanced understanding of the value and possibilities of biotechnology intellectual property. Fall BIOL2089 S01 15688 W 4:00-5:30 (J. Morgan)

BIOL 2100. Drug and Gene Delivery. Topics in drug delivery systems including history of the field, advantages of controlled release technology, stabilization and release of proteins, fabrication methods, regulatory considerations, economic aspects, patents and intellectual property rights, and more. Prepares students for research in industry and academia, and offers information for consultants in the field. Expected: BIOL 1090, 1120; CHEM 0350, 0360. Fall BIOL2110 S01 16455 M 3:00-5:30(05) (E. Mathiowitz)

BIOL 2117. Human Physiology. For Brown-Pfizer Master of arts Program students. Provides an introduction to basic human physiological concepts along with more advanced coverage of selected systems. We'll start with topics of diffusion, cell physiology and the basis of cell membrane potential and then cover the nervous, endocrine, musculoskeletal, cardiovascular, respiratory, renal and gastrointestinal systems. We’ll focus on normal human physiology and at times incorporate discussions of exercise physiology, pathophysiology, and specific physiologic scenarios to build toward the goal of understanding complex integration of function between cells, tissues and organ systems. Readings will consist of textbook chapters along with primary literature covering selected topics. BIOL 2121. The Biochemistry of Signaling and Regulation from Prokaryotes to Eukaryotes. Proteins are the engines of life. Determining how they function from a biophysical and biochemical perspective enables us to understand how they work and how we can direct and alter their activities. Proteins participate in cellular signaling pathways that are important regulators of cellular function and are often misregulated in disease. This course introduces various aspects of biochemistry involved in the analysis of cellular signaling pathways that regulate disease. Open to 12 graduate students and advanced undergraduates. Prerequisite: Students must have taken several advanced undergraduate-level courses in biology. BIOL 2125. Bioinformatics for Evidence to Improve the Discovery, Development and Use of Medicines. This course explores evidence used in decisions for discovery, development and use of medicines. Goals are i) learn issues and decision criteria for stakeholders in biomedical innovation, ii) understand challenges and emerging opportunities to improve the evidence used to make decisions over the life of a therapeutic, iii) apply this learning to develop a novel call for proposals for multi-stakeholder projects that integrate molecular and clinical knowledge for improving discovery, development and/or use of medicines for Parkinson’s disease or pancreatic cancer. This course introduces various aspects of biochemistry involved in the analysis of cellular signaling pathways that regulate disease. Open to 12 graduate students and advanced undergraduates. Prerequisite: Students must have taken several advanced undergraduate-level courses in biology. BIOL 2125. Bioinformatics for Evidence to Improve the Discovery, Development and Use of Medicines. This course explores evidence used in decisions for discovery, development and use of medicines. Goals are i) learn issues and decision criteria for stakeholders in biomedical innovation, ii) understand challenges and emerging opportunities to improve the evidence used to make decisions over the life of a therapeutic, iii) apply this learning to develop a novel call for proposals for multi-stakeholder projects that integrate molecular and clinical knowledge for improving discovery, development and/or use of medicines for Parkinson’s disease or pancreatic cancer. This course introduces various aspects of biochemistry involved in the analysis of cellular signaling pathways that regulate disease. Open to 12 graduate students and advanced undergraduates. Prerequisite: Students must have taken several advanced undergraduate-level courses in biology. BIOL 2125. Bioinformatics for Evidence to Improve the Discovery, Development and Use of Medicines. This course explores evidence used in decisions for discovery, development and use of medicines. Goals are i) learn issues and decision criteria for stakeholders in biomedical innovation, ii) understand challenges and emerging opportunities to improve the evidence used to make decisions over the life of a therapeutic, iii) apply this learning to develop a novel call for proposals for multi-stakeholder projects that integrate molecular and clinical knowledge for improving discovery, development and/or use of medicines for Parkinson’s disease or pancreatic cancer. This course introduces various aspects of biochemistry involved in the analysis of cellular signaling pathways that regulate disease. Open to 12 graduate students and advanced undergraduates. Prerequisite: Students must have taken several advanced undergraduate-level courses in biology.

BIOL 2130. Techniques in Molecular and Cell Science. This course provides hands-on laboratory training in state-of-the-art techniques in molecular and cellular sciences, and reinforces this training with didactic lectures that stress key principles, the quantitative approach and the most exciting applications of these technologies in the context of current research. Areas covered include cell culture, tissue engineering, DNA cloning, gene therapy, quantitative assays, microscopy and image analysis. Enrollment is limited to 12; written permission required. Permission will be granted after the first class. Students MUST register for the lecture section and a lab. BIOL 2135. Pharmacokinetics and Drug Design. Consists of the absorption, distribution, metabolism, and elimination of drugs. These factors, including dosage, determine the concentration of drugs at its sites of action, and intensity of effects. Will examine models describing the relationship between plasma drug concentrations and therapeutic drug effect. Will acquire biologic sampling techniques, analytic methods for measurement of drugs and metabolites, and procedures facilitating data used in designing drugs and dosage regimens. Prerequisite: BIOL 0800 or equivalent. Enrollment limited to 20. Preference given to graduate students in Biotechnology and BME, especially Masters students. Graduate students (PhD and ScM) from other programs enroll if permission of instructor is granted. BIOL 2140. Principles in Experimental Surgery. An introduction to the principles and practice of surgery, sterile technique, anesthesia, and laboratory animal care. Intended to provide highly supervised, hands-on experience in techniques for humane handling and surgical management of experimental animal subjects. Emphasizes surgical technique, anesthesia technique, and laboratory animal medicine. Prerequisite: BIOL 0800. Limited to five (5) Graduate students only. Instructor permission required. Students MUST register for the lecture section and the lab. BIOL 2145. Molecular Targets of Drug Discovery. This course emphasizes the role of cell physiology in the identification of drug targets and the development of novel drugs. Specific protein drug targets such as G-protein coupled receptors will be examined in detail from identifying a target to development of drugs for that target and the physiological consequences. Prerequisite: BIOL 0800. Enrollment limited to 20. Preference is given to graduate students in Biotechnology and BME, especially Masters students. Graduate students from other programs may enroll if permission of the instructor is granted. BIOL 2150. Scientific Communication. Focused on the effective dissemination of scientific information. Through practical examples of activities common to the profession (writing a grant proposal, presenting research work orally, and preparing a critical review of a submitted scientific manuscript), students will develop the skills necessary to effectively communicate scientific ideas, experiments and results. Each of the activities will be dissected into key sets that will be individually developed with the aid of interactive discussions and peer review. Enrollment limited to 12 graduate students. Fall BIOL2150 S01 15688 W 2:00-3:30 (K. Mowry) Fall BIOL2150 S02 15687 W 2:00-3:30 (J. Bender) BIOL 2156. Special Topics in Biotechnology Writing. This course is open to Biotechnology Masters students not involved in lab-based research. Students choose from a list of topics and faculty mentors in the field of biotechnology. Teams conduct in-depth research and writing, with the goal of producing a final report and presentation equivalent to a professional consultant’s report. Students meet weekly with mentor to monitor progress. Prerequisite: BIOL 0280 and 1120; CHEM 0350/0360 or equivalent. Enrollment limited to 20 students. Instructor permission required. Course is offered in both, Semester 1 and 2, and may be repeated once for credit. Spr BIOL2156 S01 25025 Arranged (E. Mathiowitz) BIOL 2160. Analytical Methods in Biotechnology. This course will cover principles and practical applications of important analytical tools used in the field of Biotechnology. Topics covered include spectroscopy, chromatography, and physical and chemical methods of characterization of a variety of molecules used for therapeutic applications. The molecules will range in size from traditional drugs with molecular weights of less than 1000, peptides and proteins as well as siRNA and industrial polymers. This course is suitable for students intending on pursuing a career in biomedical research in academia or industry. Prerequisites: BIOL 0280, BIOL 1120, CHEM 0350/0360, or equivalent course. Enrollment limited to 20 Masters students in Biotechnology and BME.
BIOL 2170. Molecular Pharmacology and Physiology.
Fundamental concepts in pharmacology and physiology from the cellular/molecular level to organ systems. Required of first-year graduate students in Molecular Pharmacology and Physiology.
Fall BIOL2170 S01 15688 MWF 10:00-11:30 (D. Horrigan)

BIOL 2180. Experiential Learning Industry, ELI.
Experiential Learning in Industry is restricted to biomedical engineering (BME) Sc.M. and biotechnology (Biotech) Sc.M. students, permission also required. The course is an extended in-depth learning experience in an industry environment related to the discipline of BME and Biotech. Industry environments include: medical device, pharmaceutical or biotechnology and industries that provide BME and Biotech relevant services to the aforementioned companies including patent law, licensing, regulatory and consulting. Students will pursue Experiential Learning in Industry during one summer plus one semester or during two semesters for which they will receive credit towards their degree. This course is restricted to BME and Biotech Masters students only. Students must have successfully completed the first year of the BME Masters Program. Slots are limited so permission is required.
Fall BIOL2180 S01 15689 Arranged (B. Zielinski-Habershaw)
Spr BIOL2180 S01 25026 Arranged (B. Zielinski-Habershaw)

BIOL 2190. MPPB Professional Development Seminar.
Professional development seminar required of all first year graduate students in the Molecular Pharmacology and Physiology Graduate Program, and open to graduate students in other programs. Topics include grants and funding, effective oral presentation skills, alternative careers in science, and others. All students will be required to present a research seminar during the scheduled class time.
Instructor permission required for graduate students outside the Molecular Pharmacology and Physiology Graduate Program. Not intended for undergraduate students.
Fall BIOL2190 S01 15690 M 12:00-1:30 (D. Horrigan)

BIOL 2200A. Molecular Biology and Chemistry.
A critical evaluation of contemporary research in biochemistry, molecular biology, and structural biology. Intensive reading and discussion of the current literature, critical analysis, and student presentations in seminars. Advanced undergraduates with permission. Enrollment limited to 20.

BIOL 2200B. Post—Transcriptional Regulations of Gene Expression.
Enrollment limited to 20.

BIOL 2200D. Current Topics in Biochemistry: Biochemical Genomics.
A critical evaluation of current research in biochemistry and molecular biology focusing on the mechanism and regulation of transcription. Intensive reading, critical analysis, and discussion of the relevant literature in the context of student presentations in seminars. Advanced undergraduates with permission of the instructor. Enrollment limited 20 students. Instructor permission required.

BIOL 2210A. Molecular Mechanisms in Site—Specific Recombination and DNA Transposition.
Enrollment limited to 20.

BIOL 2210C. Current Topics in Molecular Biology: Cellular Quality Control Mechanisms.
Protein synthesis is a fundamental cellular process that is dependent upon the rapid and accurate synthesis of tens to hundreds of thousands of ribosomes per generation to carry out the equally rapid and accurate synthesis of protein. Progress in understanding Ribosome structure and function, Ribosome evolution, Ribosome biogenesis and coordination of cell growth with cell division will be explored using the current literature with weekly student seminars and a final research proposal.

BIOL 2220. Biomedical Engineering and Biotechnology Seminar.
Biomedical engineering and biotechnology are interdisciplinary fields that incorporate progress in biomedical sciences, the physical sciences, and engineering. To achieve success in these fields requires facility with interdisciplinary oral communication – this is the specific and practical focus of this course. Each week, students will give research presentations and receive feedback from the audience to help improve their public speaking skills.
Fall BIOL2220 S01 15795 T 4:30-7:00 (E. Darling)
Spr BIOL2240 S01 25027 T 4:30-7:10 (J. Morgan)

Blood serves many critical functions including respiratory gas transport, hemostasis and host defense. Plasma and cellular components of blood, their functional mechanisms, pathophysiologic consequences when deficient and current treatments will be reviewed. Finally, development of blood component substitutive therapeutics (blood substitutes) based on protein and cellular engineering technologies (biotherapeutics) will be discussed. Open to Graduates students and Juniors and Seniors who meet the pre-requisites BIOL 0800 and BIOL 0280 or with instructor’s permission.
Fall BIOL2245 S01 15805 MW 10:30-11:50 (H. Kim)

BIOL 2260. Physiological Pharmacology.
The objective of this course is to present drugs in the context of the diseases they are used to treat. A list of the Common medically prescribed drugs will be discussed in terms of their fundamental modes of action and clinical importance. Pertinent background biochemistry, physiology, and pathology is provided, e.g., the electrophysiology of the heart is discussed as a background to anti-arrhythmic drugs. Course is relevant for students interested in medicine journalism, law, government, precollege teaching, biomedical research, and pharmacy. Expected: background in physiology. For graduate students ONLY register for BIOL 2260 (enrollment limit 15); all others BIOL 1260.
Fall BIOL2260 S01 15808 TTh 10:30-11:50(13) (J. Marshall)

BIOL 2270. Advanced Biochemistry.
(Undergraduate students should register for BIOL 1270.)
Fall BIOL2270 S01 15816 TTh 2:30-3:50(03) (A. Deaconescu)
BIOL 2290A. Mechanisms of Virus Entry, Replication, and Pathogenesis.
This course will focus on the interactions between viruses and host cells that contribute to invasion, manipulation of viral and cellular gene expression, and manipulation of the host's response to infection. We will address interactions between viruses infecting humans, as well as those of plants, fungi, and bacteria. Students will be evaluated on their ability to critically analyze data in published manuscripts, including presentations of primary papers, classroom discussion, and completion of a research proposal. Expected: at least two of the following: BIOL 1050, 1270, 1520, 1540, 1560. Advanced undergraduates with permission of the instructor.

BIOL 2290B. Mechanisms of Protein Synthesis and Impact on Human Disease.
This course will examine mechanisms central to the regulation of protein synthesis in both prokaryotes and eukaryotes. Targeting protein synthesis through ribosomes is a proven drug target commonly used to treat many infectious diseases. The regulation of protein synthesis in eukaryotes is critical for myriad human conditions including aging and cancer, including the recently discovered role of microRNAs. This course will explore the common and unique mechanisms of regulation of protein synthesis between prokaryotes and eukaryotes and the importance of understanding these mechanisms for human health. For graduate students and advanced undergraduates with permission of the instructor.

BIOL 2290C. Neuronal Signaling meets the RNA World.
The concept of one gene, one protein is nowhere more violated than in protein encoding genes expressed in the nervous system. We will cover a variety of post-transcriptional processing events which serve to generate protein diversity in the nervous system including alternative splicing, trans-splicing, and RNA editing. We will also address non-coding RNAs and their roles, in particular, in regulating nervous system function. Since it is clear that nervous system complexity is not a function of gene number across large phylogenetic distances, the course will be aimed at instilling a greater understanding of how the regulation of shared "toolkit" genes results in organismal complexity. Advanced undergraduates with permission of the instructor.

BIOL 2290D. Small RNA Regulation of Germ Cells and Development. Enrollment limited to 20.

BIOL 2290E. Signal Transduction.
This seminar course will provide a broad introduction to basic mechanisms of cell signaling from the extracellular environment to the nucleus of a cell, and to the mechanisms that regulate signal transmission. Topics of discussion will include: processing and modification of signaling molecules; signal recognition/ligand binding; co-receptors and receptor trafficking; intracellular relays; transduction to the nucleus; regulation of signal intensity and duration; feedback controls. Signal transduction pathways from several model systems will be examined and their relevance to development and disease will be considered. Senior undergraduates with permission of the instructors. Enrollment limited to 20.

BIOL 2310. Developmental Biology.
Covers the molecular and cellular events of development from fertilized egg to adult. Genetic basis of body form, cell fate specification and differentiation, processes controlling morphogenesis, growth, stem cells and regeneration are examined. Differential gene regulation, intercellular signaling and evolutionary conversation are central to discussion of mechanisms governing developmental processes. Additional topics: developmental plasticity, impact of epigenetic and environmental factors, and basis of disease gleaned from developmental biology research. Live embryos complement and reinforce concepts covered in class. Expected: BIOL2020 (or equivalent), and one course in genetics, embryology, cell biology or molecular biology. Enrollment limited to 36. (Undergraduate students register for BIOL 1310.)

BIOL 2320E. Genetic Control of Cell Fate Decisions. Fall
A cell’s fate is acquired in a process whereby largely uncommitted progenitor cells are instructed down a commitment path that ultimately results in a specific cell type with distinct molecular and physiological properties. This process is critical for the establishment of all cell types and tissues and is poised to be a critical topic in cell-based therapeutic strategies. We will investigate the intrinsic and extrinsic mechanisms that manifest at the genetic level to impart cell fate decisions on progenitors. Advanced undergraduates with permission of the instructor.

BIOL 2340. Neurogenesis and Disease. Fall
Genetic mutations provide a powerful approach to dissect complex biologic problems. We will focus on fascinating discoveries from "forward genetic" studies – moving from nervous system phenotype to genetic mutation discovery. There will be an emphasis of neurologic disease phenotypes and the use of novel genomic methods to elucidate the central molecular and cellular causes for these conditions. The course will emphasize the use of "reverse genetics" – engineered mutations in model systems – to dissect nervous system function and disease mechanisms. Disorders to be covered include autism, intellectual disability, schizophrenia, epilepsy. Enrollment limited to 20. Instructor permission required.

BIOL 2350. The Biology of Aging. Fall
Studying the mechanisms underlying the process of aging promises to be one of the next frontiers in biomedical science. Understanding the biology of aging is important for the long-term possibility of increasing life span, and for the immediate benefits it will have on age-related diseases. As demographics of industrialized countries have changed, age-related diseases such as cancer/cardiovascular/stroke, osteoporosis/arthritis/Alzheimer's have assumed epidemic proportions. Understanding the aging process is a pre-requisite for designing interventions for treatment. Focus is on examining the biology of aging through the examination of a molecular/cellular/genetic and demographic nature. Suggested prerequisites: BIOL 0200, 0280, 0470, 0800. Enrollment limited to 20. Advanced undergraduates with permission of instructor.

BIOL 2430. Topics in Ecology and Evolutionary Biology. Fall
Current literature in ecology, behavior, and evolutionary biology is discussed in seminar format. Topics and instructors change each semester. Representative topics have included: structuring of communities, biomechanics, coevolution, quantitative genetics, life history strategies, and units of selection. Expected: courses in advanced ecology and genetics.

BIOL 2440. Topics in Ecology and Evolutionary Biology. Spr
See Topics In Ecology And Evolutionary Biology (BIOL 2430) for course description.

BIOL 2450. Exchange Scholar Program. Spr
Fall BIOL2450 S01 15100 Arranged "To Be Arranged"
Fall BIOL2450 S02 15101 Arranged "To Be Arranged"

BIOL 2528. Innovation and Commercialization in Medical Devices, Diagnostics, and Wearables. Spr
This course provides a comprehensive overview of concepts and steps involved in developing and commercializing novel technology/scientific breakthroughs for medical devices, diagnostics and wearables. This course is particularly suitable for students interested in pursuing a career within a medical device segment, or creating innovation-based companies, as well as for those interested in developing an in-depth knowledge of evolution of medical devices from research concepts to products in the market.

BIOL 2529. Biology (Graduate)
Even in this era when whole genome DNA sequencing has become routine, there are still thousands of eukaryotic genes with unknown functions. Genetic screens for mutations that alter pathways of interest remain the premier approach to understanding gene function in the context of the organism. In Molecular Genetics students will learn the key concepts involved in designing and interpreting genetic screens using the powerful tools available in model animal, plant, and fungal organisms. Students will also learn how to understand and analyze results presented in the primary scientific literature. Furthermore, students will gain an appreciation of how the field of genetics has changed through discoveries and technological advances made over the past 50 years. Undergraduate students should register for BIOL 1540.

Biol 2540A. Viral Immunology.
Viral Immunology is an advanced topics course in Microbiology and Immunology which will be focused on viral immunology. Weekly meetings will cover different issues concerning defense against viral infections and pathology related to viral infection, with focus on viral-host interactions. Topics will be selected to present either important basic concepts in the context of immune responses and/or major challenges in controlling viral infections. Recent advances in understanding virus-host interactions, host responses to viruses, cytokine regulation of immune responses or cytokine-mediated pathology during viral infections will be emphasized.

Biol 2540B. Microbial Pathogenesis.
Examines microbial pathogens and the underlying mechanisms by which infectious organisms cause diseases. Bacterial, fungal, protozoal and viral pathogens will be studied using tools of modern biology. Also examined are the host's immune responses to infection and disease. Areas covered include mechanisms of pathogen internationalization and survival, immune responses, signal transduction and pathophysiology. Expected: BIOL 0510, 0530, or 1550.

Biol 2540C. The Immune System.
Introduction to the experimental and theoretical foundations of immunology and the function of the mammalian immune system. Focuses on concepts, landmark experiments and recent advances. Topics include innate and adaptive immunity; structure/function of antibody molecules and T cell receptors; and regulation of immune responses through cellular interactions. Application of concepts to medically significant issues (vaccines, transplantation, hypersensitivity, autoimmunity, cancer, immunodeficiency) is discussed. Interpretative analysis of experimental data is emphasized. Activities include written assignments that analyze a hypothetical immune system and a final paper addressing an immunological topic of the student's choosing. For Pfizer students only.

Biol 2850. Introduction to Research in Pathobiology.
Introduces incoming pathobiology graduate students with research opportunities in the laboratories of program faculty. Consists of seminars with individual faculty members in the graduate program in pathobiology. Required background reading of recent papers lead to a discussion of current research in the faculty member's laboratory. Additional discussions include safety and ethical issues in research. Open only to first-year graduate students in the program in pathobiology.

This course is designed for graduate students and focuses on the underlying causes of human disease. Students should have a solid background in the life sciences with an understanding of the fundamental principles of molecular biology, genetics, biochemistry and cell biology. A discussion of cystic fibrosis, using this disease to explore basic principles of molecular biology, genetics, physiology and pathology. Then the course centers on the genetic and environmental basis of disease and carcinogenesis. Will lecture individual student presentations and experimental planning exercises. Emphasis will be placed on the development of presentation skills and research design. Undergraduates require instructor permission.

Biol 2970. Preliminary Examination Preparation.
For graduate students who have met the tuition requirement and are paying the registration fee to continue active enrollment while preparing for a preliminary examination.

Biol 2980. Graduate Independent Study.
Independent study projects at the graduate level. Section numbers vary by instructor. Please check Banner for the correct section number and CRN to use when registering for this course.

Biol 2985. Graduate Seminar.
Section numbers vary by instructor. Please see the registration staff for the correct section number to use when registering for this course.

For graduate students who have met the tuition requirement and are paying the registration fee to continue active enrollment while preparing a thesis.

Section numbers vary by instructor. Please see the registration staff for the correct section number to use when registering for this course.

BIOL 2995. Thesis.

Fall BIOL2995 S01 25151 F 2:30-3:50(11) (J. Bender)

Spring BIOL2995 25151 F 2:00-3:40 (C. Biron)

Correct section number to use when registering for this course. Section numbers vary by instructor. Please see the registration staff for the correct section number to use when registering for this course.

BIOL 2995. Thesis.
Section numbers vary by instructor. Please see the registration staff for the correct section number to use when registering for this course.
Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

Helvetica was used instead of Arial.

The editor may contact Leepfrog for a draft with the correct fonts in place.