Biology

The Master of Arts in Biology program helps students to update and deepen their knowledge of the biomedical sciences, prepare for employment in related fields, and advance their professional standing while obtaining a graduate science degree on a part-time basis through evening, weekend and online courses.

Designed to be adaptable to each individual's unique background and goals, the program provides a flexible curriculum and close individual advising for each student. Students include science and health professionals, teachers, technicians, and individuals in biology-related businesses.

Students in this program have the option of choosing a concentration in neurobiology for deeper, more focused study.

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Degree Requirements

Master of Arts in Biology

Students seeking the Master of Arts in Biology must satisfactorily complete 30 units of graduate courses in the biological sciences, including a required capstone experience (http://ucollege.wustl.edu/programs/graduate/masters-biology/final-project), which occurs after they have completed 21 units in the program and is chosen from the following options:

1. Complete U29 Bio 401 Problem Based Learning in the Biomedical Sciences
2. Complete a 3-unit independent study
3. Complete a 6-unit master's thesis: Students with appropriate backgrounds, interests and academic qualifications may, with authorization, write a master's thesis based on original or library research.

Note: The above options cannot count as the capstone experience if they occur before a student has completed 21 units toward the Master of Arts in Biology.

Optional Concentration for the AM in Biology

University College students who are admitted to the AM in Biology program may select an optional concentration in neurobiology. Neurobiology is the study of the structure and function of the nervous system. This concentration helps prepare students for careers in biomedical fields, including research and clinical practice in medicine, neuroscience and cognitive science. The optional concentration requires 12 units of courses as specified below:

Choose four of the following courses:

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<th>Code</th>
<th>Title</th>
<th>Units</th>
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<td>Bio 435</td>
<td>Neurobiology</td>
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<td>Bio 436</td>
<td>The Neural Basis of Behavior</td>
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<td>Bio 4721</td>
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<td>Bio 478</td>
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Credit Transfer

A maximum of 6 credits of related and comparable graduate-level courses may be transferred from another university or from a related graduate program at Washington University with the approval of the program director. These must be graduate-level units not used to fulfill undergraduate degree requirements. Transfer credit may be granted only for authorized courses for which the student received a grade of B or higher.

Please note that the AM in Biology degree is a terminal graduate degree awarded on the basis of the completion of courses rather than research. Except in rare cases, it is not intended as preparation for a PhD degree. No more than 6 of the 30 credits may be earned in research courses. Those students interested in graduate research or in earning a PhD should apply to the PhD programs offered by Washington University's Division of Biology and Biomedical Sciences (http://dbbs.wustl.edu).

Courses


U29 Bio 400 Independent Study

Requires written proposal, instructor, coordinator and deans approval in University College
Credit variable, maximum 3 units.

U29 Bio 401 Problem Based Learning in the Biomedical Sciences

Have you ever wondered how doctors and scientists diagnose and discover cures to modern human afflictions? In this course, small groups of students take responsibility for their own active, inquiry-based learning on biological problems that puzzle modern scientists. Instructors from the Washington University School of Medicine guide students on how to conduct in-depth research on issues of current biological importance. Learning how to read and interpret current research articles from the scientific literature is emphasized. Weekly topics from previous years have included cancer therapy, infectious diseases, CRISPR, microbiome, stem cells, gene therapy, and Zika viruses. Students should have broad interests and background in general biology and chemistry and should be curious, exploratory, interactive, and willing to try an active, non-
U29 Bio 4022 Viruses and the Diseases They Cause
The goal of this course is to understand different families of viruses. We will discuss the diseases that they cause, mechanisms they use to evade host defense mechanisms, and current therapies used to treat these viruses. Prerequisites: General Biology I and II or permission of the instructor. Credit 3 units.

U29 Bio 4024 Biology of Human Disease: Research, Diagnosis, Prevention, Treatment
This course examines inherited and acquired human diseases such as AIDS, cystic fibrosis, Alzheimer’s, Parkinson’s, and diabetes to help us better understand the complex nature of human diseases. We explore how normal cell functions are affected by genetic mutations, environmental stress, and infections, and how these, in turn, disturb normal tissues and organ function and produce a disease. We will learn how latest advances in basic, translational, and clinical research changes our understanding of the underlying causes of human diseases and drives development of new effective methods of diagnosis, prevention, and treatment. Prerequisites: General Biology I and II or permission of the instructor. Credit 3 units.

U29 Bio 4029 Introduction to Medical Histology
This course is for master’s students, as well as premedical and other pre-professional students who want to become proficient in the investigation of complex organs in the second half of the semester. Medical correlates are stressed. Exams are written, on-line, and in-class utilizing microscopes. Prerequisites: College-level Biology and Chemistry. Credit 3 units.

U29 Bio 4041 Evolutionary Nutrition
This course explores the interrelationships between human nutritional requirements/adaptations and evolution. We will examine ideas and evidence concerning such concepts as biochemical individuality, the genetotrophic principle, and orthomolecular medicine, among others. Lecture-discussions will focus on material from the texts recommended for this course. Drawing upon the latest research into the original human diet (from peer-reviewed scientific journals), students will then lead in-class presentation-discussions related to lecture topics. The overall objective of this course is to understand how each individual’s unique body chemistry gives rise to their specific “metabolic type” with its own specific nutritional requirements. Voluntary participation in various means of determining your own metabolic type will be offered throughout the semester. Prerequisite: Introductory Biology course; familiarity with molecular biology and evolutionary concepts. Credit 3 units. UColl: OLI

U29 Bio 405 Introduction to Molecular Biology
This course is intended to provide a background understanding of the fundamental principles of cellular processes at the molecular level. Among the major topics covered are nucleic acid chemistry, gene structure and organization in prokaryotes and eukaryotes, recombinant DNA technology, and gene expression and protein synthesis. This includes a discussion of the various mechanisms of genetic recombination and DNA damage/repair, as well as regulation of gene expression and protein modifications that occur in cells. Students will also be introduced to the concept of genome sciences and mice transgenic technology. Various special topics such as protein and membrane trafficking and mechanisms of signal transduction are also covered. Throughout the course students will learn about the major molecular techniques that have revolutionized the study of modern biology, with emphasis placed on methodologies utilized to address diverse topics such as forensics/DNA profiling, or gene expression in eukaryotes. Credit 3 units.

U29 Bio 4066 Tropical Marine Biology
This course explores the coastal and marine ecosystems of the tropics. We examine the biological and ecological processes that influence ecosystem dynamics and biodiversity within coral reef, seagrass, shoreline, and mangrove communities. We discuss the threats to coastal and marine ecosystems worldwide. Lectures are interspersed with student presentations and discussions of primary literature. Prerequisite: General Biology I. Credit 3 units. UColl: OLI

U29 Bio 413 Environmental Science: Regional and Global Perspectives
This course examines the interrelationships between humans and their environment, moving from local and regional views up to a global perspective. Taking an ecosystem approach, the course starts with basic ecological principles necessary for understanding our environment. We will then explore how environmental science incorporates concepts from politics, social sciences, economics, ethics, and philosophy; physical and biological resources; conservation, management, sustainability, and restoration; population principles; environmental economics; human impacts (especially pollution and disturbance);
environmental health and toxicology; and environmental policy. Lectures and discussions will focus on the major issues involved in environmental challenges, drawing on current, carefully selected articles from some of the most respected magazines, newspapers, and journals published today. Prerequisite: General Biology I or permission of the instructor. Credit 3 units. UColl: OLI

**U29 Bio 4130 Environmental Medicine**

Environmental Medicine explores the interactions between the environment and human health, focusing on the role of the environment in causing or mediating disease. Environmental hazards are examined in terms of toxicity, epidemiology, exposure assessment, risk assessment, individual susceptibility, adaptation/maladaptation, and the total load concept. Prerequisite: General Biology I or permission of the instructor. Credit 3 units. UColl: OLI

**U29 Bio 4140 Endocrine Physiology**

Biochemical, physiological, and regulatory properties of the mammalian endocrine system at the molecular, cellular, and systemic level with a focus on human physiology and development. Topics will explore endocrine cell signaling, molecular mechanisms of hormone action, homeostasis and feedback systems including neuroendocrine integration of physiological processes, endocrine control of cardiovascular and calcium homeostasis, and select discussion of endocrine pathologies. In addition to class and textbook material there will be exposure to the primary research literature. Credit 3 units.

**U29 Bio 4151 Biology and Biochemistry of Aging**

This course covers basic molecular and cellular aspects of the vertebrate immune system emphasizing specific and nonspecific host defense against disease, the nature of immunological specificity, and its underlying molecular genetics. We also cover immunoneurology and its use in immunoassay systems, the nature of cell activation, cytokines, tolerance and autoimmunity, allergic reactions, blood groups, transplantation reactions, immunodeficiency, and complement systems. Two or more of the following courses are recommended: Biochemistry, Cell Biology, Molecular Biology/Nucleic Acids, Microbiology/Immunology, Pathology/Pathobiology. Does not apply to day undergraduate biology major or College of Arts and Sciences distribution requirement. Credit 3 units. UColl: OLI

**U29 Bio 4242 Immunology Laboratory**

The Immunology Laboratory will introduce students to a variety of common, broadly useful immunological techniques and then allow each student to employ most of the learned techniques in addressing a current research question. Experiments will employ mouse cells in vitro and will emphasize quantitative analysis of the data. Prereq: Bio 424 and permission of instructor. Same as L41 Biol 4241 Credit 3 units. A&S IQ: NSM Arch: NSM Art: NSM BU: SCI

**U29 Bio 431 Conservation Biology and Biodiversity**

This overview of the fields of conservation biology and biodiversity covers topics such as species preservation, habitat restoration, refuge design and management, and human population growth. Does not count for day, undergraduate Biology major. This is a fully online course. Only University College students receive credit for fully online courses. Credit 3 units. UColl: OLI

**U29 Bio 432 Regenerative Medicine: Cell Based Therapies and Tissue Engineering**

Regenerative medicine focuses on the development of novel therapies to repair, replace, restore or regenerate cells, tissues and body organs that are defective, damaged or injured by disease. Cell-based therapies, including the use of native stem or immune cells and genetically-modified or bioengineered cells, are being evaluated for treatment of a wide variety of diseases such as cancer, diabetes, and Parkinson's disease. This course will highlight basic, translational, and clinical advances in cell-based therapies and tissue engineering, with some discussion of ethical, financial, and regulatory issues that may impact such advances. Prerequisites: General Biology I and II or permission from the instructor. Credit 3 units.

**U29 Bio 435 Neurobiology**

An extensive introduction to neurobiology. Starting with the elementary building blocks of the nervous system, neurons, the course covers development and regeneration of the nervous system, properties of neurons and glia, ionic basis of signaling and neurotransmitters, neural circuits and the generation of behavior, and brain function in health and disease. Introduction to the latest techniques available to the modern neuroscientist. Guest speakers and discussion sessions. (Not applicable for undergraduate biology major.) Credit 3 units. UColl: OLI
U29 Bio 436 The Neural Basis of Behavior
This course provides an overview of how the nervous system works from a biological perspective. We will begin by studying how nerve cells function, focusing on how they transmit signals and communicate with one another through specialized connections called synapses. We will further examine the anatomy of the nervous system to discover how nerve cells are organized into circuits and how these circuits develop. Finally, we will investigate how the specialized properties of our nerve cells allow us to interact with our environment through an in-depth study of our motor and sensory systems. Prerequisites: General Biology I and II or permission from the instructor. Credit 3 units. UColl: OLI

U29 Bio 438 Virology
This course is designed to provide an overview of the field of virology. The first half of the course will focus on strategies used by viruses to enter host cells, transcribe genes, replicate, assemble progeny viral particles and exit the host cell. The second half of the course will focus on recent advances and problems arising in the field of virology. We will discuss the host response to viruses, the use of viruses as vectors for vaccines and gene therapy, the role of viruses in eliciting cancer as well as the evolution of viruses and emerging viral diseases. Credit 3 units.

U29 Bio 4391 Modern Genetics
Modern concepts in genetics from Mendel to the latest in genetic engineering. Discussion of DNA manipulation techniques with emphasis on human genetics and practical applications. Suitable for, but not limited to, science teachers, medical technicians, and health care workers. Prerequisite: see headnote. Credit 3 units.

U29 Bio 4501 Evolution
Evolution, in its broadest senses, is the fundamental unifying theory in biology; as such, its scope is arguably the greatest in all the biological sciences. This course is intended to provide a framework for understanding advanced concepts of evolutionary biology. Particular emphasis will be placed on how knowledge of evolutionary theory can be applied to the problems of today? world and to providing a general understanding of the diversity of life on earth and its origins. The course will cover both micro and macro-evolution and include topics such as natural, kin, and sexual selection; the ecological context of adaptation, specialization, coevolution, as well as misconceptions described by opponents of evolutionary biology. Prerequisite: General Biology I. Credit 3 units. BU: SCI

U29 Bio 4561 Introduction to the Biotech Business
The course will provide an introduction into the world of commercializing biotech innovations. In the U.S., most discovery research originates at the university level and is transferred, via licensing agreements, to industry partners or to start-up biotech companies for final development and commercialization. The process of moving this innovation from the lab to industry and then to the patient is a focus of this course. The course will be offered in two sections, the first providing insights into the socio-economic environment that fostered the biotech revolution and the key drivers that influence decisions on what research to commercialize. The primary focus is on medical biotech but agricultural biotech is also examined. The second section deals with biotech entrepreneurship and investigates issues and choices that inventors / scientists encounter when they are considering the applications and commercialization of early stage scientific discoveries. In addition to studying the complex relationship between science and business, the course employs a case study methodology to illustrate specific examples of the translational process from lab to marketed product. Preparation for classes will be done individually with all students completing readings prior to each class. Each student should be prepared contribute to the class discussion and to lead the class discussion of the assigned reading materials, if called upon to do so. A team-based feasibility study, with a team presentation at the end of the semester is integral to the course. Credit 3 units.

U29 Bio 458 Readings and Research in Biomedical Sciences
Each day, more than 5000 new biomedical research articles are published. As a future physician and scientist, you will need to be able to identify and stay current on medical advancements. Medicine is interdisciplinary, and a successful scientific career means being able to make connections between diverse research fields. The goal of this journal club is help students develop skills for locating, analyzing, and understanding scientific research articles. Students will learn how to locate primary journal articles using a variety of search engines such as PubMed and Ovid, and practice reading articles outside of their comfort zone without being intimidated by scientific jargon and formal writing styles. Students will be expected to discuss current research articles and develop effective scientific writing skills by analyzing the main sections of a scientific manuscript (Abstract, Background, Methods, Results, Discussion, Conclusion, Implications). Credit 2 units.

U29 Bio 4590 Advanced General Physiology
This graduate-level course will examine physiology in a cohesive evolutionary context. For each system we will first review the general anatomy and physiology, turning then to the molecular basis of function and dysfunction. Each class provides an overview of the basic physiology of one of the major organ systems including: neural, respiratory, cardiovascular, endocrine, digestive, urogenital and immune, followed by a discussion of recent discoveries presented in primary scientific literature and current reviews. Prerequisites: General Biology I and II, and Anatomy & Physiology is also recommended. Credit 3 units.

U29 Bio 462 Behavioral Ecology
This graduate-level course will examine animal behavior in an evolutionary context. We will evaluate models of behavior ranging from optimal foraging, mimicry, and communication to sexual selection, kin recognition, and social behavior. Each class will begin with a lecture reviewing the theory on the weekly topic. We will then discuss recent articles on that topic from the current literature. Each week different students will be responsible for preparing a brief presentation outlining the selected articles and will lead a discussion examining the methods, analysis and interpretation. Credit 3 units.

U29 Bio 463 Global Health Issues
This course is designed to inform and challenge participants to observe and solve problems relating to world health issues while teaching basic biology concepts. Participants will investigate barriers to solving problems of Nutrition, Infectious disease and Environmental factors that prevent progress of global

U29 Bio 465 Global Health Issues
U29 Bio 471 Topics in Cancer Biology
Over two-thirds of all people know someone who has cancer. This course aims at providing students with a more extensive understanding of what cancer is and how it affects the human body. We will discuss past and current molecular research in cancer, animal models in cancer, the many different types of human cancer, and novel cancer therapies being developed by biotechnology and pharmaceutical companies. The topics will be presented in a basic scientific nature with an emphasis on gaining a broad understanding of the subjects. Prerequisite: General Biology I.
Credit 3 units. UColl: OLI

U29 Bio 4721 The Biology of Membranes
Biological membranes not only define cell and organelle boundaries but also control the substances that are allowed to enter or exit the cell or organelle. Biomembrane structures, including composition, determine functions. The goal of this class is to examine cell membrane structure, membrane components and their organization into domains, and functions. Cholesterol is an important membrane lipid that is linked to biomembranes structurally and functionally. Misregulation of synthesis or trafficking of lipids, including cholesterol, contributes to many human diseases. Students will learn historical background and recent advances in membrane biology, following the path taken by cholesterol and others. Prerequisite: General Biology I or permission of the instructor.
Credit 3 units. UColl: OLI

U29 Bio 477 Fundamentals of Parasitology
This course covers a variety of clinically relevant parasitic organisms and their importance to human disease. We will discuss in detail the interactions of parasites with the host immune response both in terms of mechanisms whereby the host resists infections by these organisms and also how these parasites circumvent the host's ability to eliminate them. Because so much of the clinical importance of parasites has to do with this interaction, we will also cover general aspects of the workings of the immune system. There will be an emphasis on the nature of the host-parasite interaction on a molecular level. Lectures include discussions of recent literature concerning parasites and their interactions with the host.
Credit 3 units.

U29 Bio 478 Neuroscience: Sensory Systems
This course examines transduction and neural processing of various sensory inputs, including vision, audition, somatosensation, and special senses. Topics ranging from anatomy and physiology of the human sensory systems to the sensory plasticity will be discussed. Topics also include organization of sensory map, sensory reorganization, sensory integration, sensory-motor interactions and higher cognitive functions. We also discuss clinical aspects of sensory dysfunctions. We will explore landmark works and recent studies on sensory neurosciences. Prerequisite: General Biology I
Credit 3 units.

U29 Bio 480 Mechanisms of Microbial Pathogenesis
This class is designed to specifically address mechanisms whereby microbes of three basic types: Bacteria, Viruses, and eukaryotic parasites, subvert the host immune response and cause disease. The class will therefore be subdivided into three sections studying each of these three types of organisms. This
class will primarily focus on recent publications with a short lecture preceding each discussion. Credit 3 units.

U29 Bio 481 Evolutionary Medicine
Evolutionary Medicine examines how human evolution relates to a broad range of contemporary health problems including infectious, chronic, nutritional, and mental diseases and disorders. The primary goal of the course is to compare modern human environments and behaviors with the conditions under which humans evolved to determine the extent to which medical conditions of the present may be a consequence of adaptation to different conditions of the past. Hybrid online, meeting on the following Thursdays 1/29, 2/12, 2/26, 3/12, 4/9, 4/23. Credit 3 units.

U29 Bio 4811 Advanced Wilderness Medicine
This graduate-level course will cover the physiology underlying wilderness and remote first aid. In each section we will first review evidence-based, best practices and then explore the underlying mechanisms and physiology. In addition to learning the theory of emergency medical care, we will gain experience practicing life saving techniques including: CPR, wound cleaning and care, splinting of fractures and dislocations, spinal stabilization and treatment of heat stroke and hypothermia. Prerequisites: Introductory Biology and Anatomy & Physiology, or permission of instructor. Credit 3 units.

U29 Bio 485 Synaptic Change in the Nervous System
In this course, we study synapses and how they are modified by experience in development, learning, and memory. Topics include the impact of different types of synapses on neural function; activity-dependent synaptic organization during nervous system development; the link between synaptic plasticity and learning and memory; circuitry and mechanisms of explicit and implicit memory formation; and synaptic organization and function in aging. We also learn how learning and memory are altered in mood disorders and addiction, as well as how they are affected by sleep and exercise. Prerequisites: Introduction to Psychology and previous course work in biology. Credit 3 units.

U29 Bio 487 Undergraduate Teaching Assistant
Exceptional undergraduates serve as teaching assistants for laboratory and/or discussion sections in departmental courses. Normally 2 or 3 units are given per semester, subject to the approval of the instructor and the department. Credit may not be counted toward fulfilling a major in University College; Independent Study application form required. Prerequisite: permission of instructor. Credit /No Credit only. Credit variable, maximum 3 units.

U29 Bio 493 Seminar in Advanced Biology
In special cases, credit may be given for individual study. Topics of study and credit must be arranged with a faculty sponsor and approved by the Department. Same as L41 Biol 493. Credit variable, maximum 4 units. A&S IQ: NSM Art: NSM

U29 Bio 500 Independent Study
An independent research project under the supervision of a member of the Biology faculty. Open only to students admitted to the graduate program in Biology. Approved proposal must be presented at the time of registration. For more information, contact the assistant dean for Graduate Programs at 314-935-6700. Credit variable, maximum 3 units.

U29 Bio 5012 Human Anatomy and Development
Study of the human body primarily by dissection; extensive use of X-rays and CT scans. Emphasis on functional and clinical aspects of anatomy. Prerequisite: This course is restricted to first year medical students. Same as L48 Anthro 502 and M05 Neurosci 501A. Same as L41 Biol 501. Credit 6 units.

U29 Bio 5285 Fundamentals of Mammalian Genetics
This course aims to provide both biologists and those with mathematical backgrounds with a basis in mammalian genetics. The course will include the following modules: nucleic acid biochemistry; gene and chromosome organization; introduction to human genetics; mutations and DNA repair; cancer genetics; genomic methodologies; biochemical genetics; murine genetics; epigenetics; neurodegenerative diseases; mitochondrial disorders; pharmacogenetics; introduction to human population genetics; applications of modern human genetics; introduction to web-based informatics tools for molecular genetics. One of the required courses in the Quantitative Human Statistical Genetics graduate program. Same as L41 Biol 5285. Credit 3 units.

U29 Bio 5319 Molecular Foundations of Medicine
This course will cover fundamental aspects of biochemistry and cell biology from a medical perspective. The course begins with a treatment of protein structure and the function of proteins in the cytoskeleton and cell motility. The principles of enzyme kinetics and regulation are then discussed, and basic pathways for the synthesis and metabolism of carbohydrates and lipids are introduced. This leads in to a discussion of membrane structure and the function cellular organelles in biological processes including energy production, protein degradation, and protein trafficking. Prerequisite: two semesters of organic chemistry. Course director approval is required. Please note: This course is given on the medical school schedule, so it begins eight days before the graduate school schedule. Same as L41 Biol 5319. Credit 3 units.

U29 Bio 552 Human Genetics and Cytogenetics
Human or medical genetics is one of the most rapidly advancing fields of science and is now integral to all aspects of biomedical science. This course provides a genetic perspective on the function of the human body in health and disease. Beginning with a study of chromosomes and the disorders that result from their aberrations, the course presents the theoretical background necessary for a deeper understanding of the emerging impact of human genetics on biology. Topics include chromosomal basis of heredity, autosomal and sex chromosomal abnormalities, and cancer genetics. Students will be introduced to the specific molecular and cytogenetic techniques that have revolutionized the study of human genetics. Credit 3 units. UColl: OLI