The biology PhD and MS programs seek to provide a broad background knowledge base in conjunction with in-depth study of a specialized area of biology. The programs emphasize close interaction between graduate students and faculty members in developing the intellectual and experimental skills required for creative, independent research. The Master of Science in Bioinformatics seeks to prepare students to enter the research management and technology transfer fields.

The PhD program entails course work from a core biology curriculum along with advanced courses in the student’s area of research interest. This is complemented by intensive research and completion of a dissertation under faculty supervision. Faculty research includes biochemistry, microbiology, cell and molecular biology, genetics, neurobiology, regenerative biology, and the biology of reproduction.

The Master of Science in Bioinformatics is a professional program that consists of four parts: fundamental courses, core courses, an internship, and electives. All courses are available in the late afternoon or evening to accommodate those who are employed during the day.

Programs

Doctor of Philosophy (PhD)

- Biology (http://catalog.northeastern.edu/graduate/science/biology/biology-phd)
- Biology—Advanced Entry (http://catalog.northeastern.edu/graduate/science/biology/phd-advanced)

Master of Science (MS)

- Bioinformatics (http://catalog.northeastern.edu/graduate/science/biology/bioinformatics-ms)
- Bioinformatics—ALIGN Program (http://catalog.northeastern.edu/graduate/science/biology/bioinformatics-ms-align)

Courses

Biology Courses

BIOL 5100. Biology Colloquium. 1 Hour.

Offers a series of colloquia in biological research by invited experts on current topics. May be repeated without limit.

BIOL 5306. Biological Clocks. 4 Hours.

Examines the expression of endogenously generated twenty-four-hour (circadian) rhythms in eukaryotic life, emphasizing theoretical foundations as well as current research strategies for understanding how biological clocks work. Presents analytic principles for understanding biological rhythmicity in any organism at any level of organization. Emphasizes strategies used to understand the concrete mechanisms underlying biological rhythmicity.

BIOL 5307. Biological Electron Microscopy. 4 Hours.

Presents techniques of electron microscopy applied to biological materials. Discusses specimen preparation, fixation, thin-sectioning, staining, operation of the microscopes, photographic techniques, and interpretation of electron micrographs. Requires student seminars and project.

BIOL 5308. Lab for BIOL 5307. 1 Hour.

Designed for graduate and advanced undergraduate students with no formal training in electron microscopy. Offers students an opportunity to acquire a thorough working knowledge of transmission and scanning electron microscopy by having each student process specimens from living tissue through the production of electron micrographs. This involves standard specimen preparation protocols including fixation, embedding, ultramicrotomy, staining, critical point drying, and sputter coating, as well as the independent operation of state-of-the-art electron microscopy equipment.

BIOL 5499. Plant Biotechnology. 4 Hours.

Designed as an introductory course on plant biotechnology for upper-level undergraduates and first-year graduate students. Using examples from current research, offers students an opportunity to review the technology used to modify and improve economically important plants for sustainable agriculture as well as for the production of pharmaceutical and medicinal products. Specific topics include principles of plant heredity and genetics (molecular biology), plant breeding and improvement, hormones and growth regulators, gene isolation, plant tissue culture and transformation, plant-based pharmaceutical production, and stress tolerance and improvement. The course consists of weekly lectures, laboratory demonstrations, and review sessions of recent literature.

BIOL 5533. Vertebrate Microanatomy. 4 Hours.

Deals with the structure and function of cells, tissues, and organs in vertebrate animals at light and electron microscopic levels.

BIOL 5534. Lab for BIOL 5533. 1 Hour.

Accompanies BIOL 5533. Seeks to enable the student to identify microscopically the structures of cells, tissues, and organs in vertebrate animals at light and electron microscopic levels.

BIOL 5541. Endocrinology. 4 Hours.

Explores the endocrine regulation of physiological systems, emphasizing current research. Lectures provide background, followed by analysis of primary literature and case studies. Topics include growth, reproduction, nutrient utilization, stress, and environmental endocrine disruption. Emphasizes humans but includes material on other animals, including invertebrates.
BIOL 5543. Stem Cells and Regeneration. 4 Hours.
Explores the biological basis of embryonic, adult, and induced pluripotent stem cells toward an understanding of their roles in development, homeostasis, and regeneration, as well as their therapeutic potential. The study of stem cells is a rapidly advancing area in biology and biomedicine. Although the biological basis of stem cells is a major focus, the course aims to put this knowledge into a biomedical context.

BIOL 5549. Microbial Biotechnology. 4 Hours.
Offers readings and seminar-style discussion from the current literature on important inventions and practical applications in biotechnology, with a focus on drug discovery.

BIOL 5553. Biology of Muscle: Molecules to Movements. 4 Hours.
Examines the biology of skeletal muscle and movement in an integrated fashion. Considers the biochemical, physiological, and structural properties of skeletal muscle that adapt it to diverse mechanical functions. Examines the structure and function of the contractile proteins and their assembly into sarcomeres. Considers the regulation of these elements through excitation-contraction coupling. Reviews the metabolic machinery that supplies the energy for contraction, with emphasis on the regulatory systems that link energy supply and demand and the overall efficiency of contraction. Presents the architectural organization of muscle fibers and connective tissue elements to form mechanical linkages to the skeleton. This information is integrated by analyzing the function and performance of skeletal muscle during movement. Considers locomotor systems including swimming, flying, running, and jumping.

BIOL 5569. Advanced Microbiology. 4 Hours.
Focuses on how microorganisms develop, exchange, and regulate genes, and survive in various environments. Emphasizes experimental design and proof, particularly as related to genetic exchange, gene regulation, single and multicellular development, and cell-cell communication.

BIOL 5571. Microbial Ecology. 4 Hours.
Focuses on the fundamental role of microbial communities in the function of the biosphere. Surveys the diversity of microorganisms, their ecological strategies, and interactions in aquatic and soil communities, deep sea vent and subsurface rock environments, extreme conditions of Antarctic ice, and boiling springs.

BIOL 5572. Lab for BIOL 5571. 1 Hour.
Accompanies BIOL 5571. Covers topics from the course through various experiments.

BIOL 5573. Medical Microbiology. 4 Hours.
Emphasizes host-parasite interactions: virulence, toxins, natural flora, and immunological responses; characteristics of the common bacterial, rickettsial, and protozoal infections in humans; and epidemiology, pathology, vaccines, and chemotherapy.

BIOL 5581. Biological Imaging. 4 Hours.
Illustrates imaging principles and techniques and their application to biological problems. Topics vary and may include microscopic and macroscopic approaches in areas such as cellular and neurobiology, ecology, and biochemistry.

BIOL 5583. Immunology. 4 Hours.
Provides an overview of the structure and function of genes, proteins, and cells involved in the generation of the immune response. Emphasis is on molecular immunology and immunogenetics.

BIOL 5585. Evolution. 4 Hours.
Discusses history of evolutionary theory and lines of evidence. Emphasis is on mechanisms of speciation. Introduces and discusses current evolutionary topics.

BIOL 5587. Comparative Neurobiology. 4 Hours.
Presents a cellular approach to structure and function of the nervous system. Topics include neuronal anatomy, phylogeny of nervous systems, electrophysiology of membrane conductances, synaptic transmission, integration in nerve cells, neuronal networks, sensory systems, motor systems, sensory-motor integration, development and regeneration of neuronal connectivity, and fundamentals of neurotechnology for biomedics. Focuses on the development of these concepts from the primary research literature. A term project involves the design of a simple nervous system for a hypothetical animal.

BIOL 5591. Advanced Genomics. 4 Hours.
Intended for those familiar with the basics of genetics, molecular and cellular biology, and biochemistry, all of which are required to appreciate the beauty, power, and importance of modern genomic approaches. Introduces the latest sequencing methods, array technology, genomic databases, whole genome analysis, functional genomics, and more.

BIOL 5593. Cell and Molecular Biology of Aging. 4 Hours.
Covers the recent scientific discoveries that have transformed our understanding of the process of aging. Examines in-depth the current understanding of the molecular mechanisms that control life span in model organisms, including yeast, worms, flies, and mice. Discusses dietary interventions and pharmacological approaches that extend the life span and delay the onset of age-related diseases. Covers potential applications of the new science of aging to improve human health. Requires students to read, discuss, present, and report on primary research papers from the literature. Perqs: (a) BIOL 2323 and junior or senior standing or (b) graduate standing.

BIOL 5597. Immunotherapies of Cancer and Infectious Disease. 4 Hours.
Describes the basic principles and the current promises and disappointments with immunotherapies of cancer. Provides a historical overview of the main barriers between tumors and antitumor killer cells. The unifying focus of the lectures is the role of immunological and physiological negative regulators, i.e., “brakes” of anti-tumor immune response. A significant part of the course is dedicated to the retrospective evaluation of the last three decades of the immunological and biochemical studies that culminated in identification of the “chief of tumor defense operations,” i.e., a hypoxia-adenosinergic pathway in the tumor microenvironment.

BIOL 5601. Multidisciplinary Approaches in Motor Control. 4 Hours.
Studies the field of human motor control, or motor neuroscience. Offers students an opportunity to obtain a fundamental understanding of the processes underlying the acquisition and control of sensorimotor behavior. The systems approach connects a variety of disciplines ranging from neurophysiology, to engineering, to neurorehabilitation. Reviews a selection of approaches with emphasis on motor learning. Focuses on early behavioral approaches, more recent neurophysiological and imaging approaches, and rehabilitation. Discusses selected representative papers, including seminal historical papers and more recent studies reflecting the current discussion in the field.

BIOL 6299. Molecular Cell Biology for Biotechnology. 3 Hours.
Integrates biochemistry and molecular biology in the cellular context. Includes the organization and replication of genomes, principles and methods for genetic manipulation, the regulation of gene expression, and the structure and function of organelles. Emphasizes protein synthesis, including translation, post-translational modifications, and translocations of proteins within the cells and secretion.

BIOL 6300. Biochemistry. 4 Hours.
Studies the structure and function of biomolecules, with an emphasis on proteins; enzyme catalysis; and cellular metabolism, with an emphasis on bioenergetics and carbohydrate/lipid.
BIOL 6301. Molecular Cell Biology. 4 Hours.
Integrates biochemistry and molecular biology in the cellular context. Emphasizes the organization and replication of genomes, the regulation of gene expression, the structure and function of organelles, and the mechanisms of signal transduction.

BIOL 6303. Neurobiology and Behavior. 4 Hours.
Offers a lecture course that aims to provide a comprehensive overview of behavioral neurobiology, with special emphasis on a neuroethological approach. At the end of the course, the successful student should have a contemporary understanding of the historical development of the behavioral sciences, the major ethological and neurobiological concepts, and the principal mechanisms that govern behavior in animals and humans. Requires permission of instructor for those students not enrolled in bioinformatics, biology, or marine biology.

BIOL 6381. Ethics in Biological Research. 2 Hours.
Discusses ethical issues relevant to research in the biological sciences. Requires student presentations.

BIOL 6399. Dynamics of Microbial Ecology. 4 Hours.
Explores state-of-the-art research on microbial biology of the environment and human body. Focuses on molecular diversity of microbial species and microbial discovery, microbial dynamics across time and space, microbiology of extreme environments, microbial ecology in the genomics age, host-microbe interactions in the human body, and translation of basic microbiology into practice. Emphasizes how new concepts in microbial biology, such as signal-based regulation and cell individuality, may change the current views on organization and function of microbial communities in nature. Requires permission of instructor for those students not enrolled in bioinformatics, biology, or marine biology.

BIOL 6401. Research Methods and Critical Analysis in Molecular Cell Biology. 4 Hours.
Encompasses biochemical and cell biological approaches to understanding cell structure and function, including membranes, organelles, vesicle trafficking, cytoskeleton, cell cycle, and signaling. Structured activities integrate critical analysis of recently published literature and methods. Offers students an opportunity to prepare for the professional practice of molecular cell biology. Permission of instructor required for those students not enrolled in biology.

BIOL 6405. Prokaryotic Cell and Molecular Biology. 4 Hours.
Provides in-depth discussion about fundamentally important cellular processes in prokaryotic systems—such as replication, transcription, and translation—and the corresponding regulatory mechanisms. Also discusses molecular mechanisms of gene regulation and bacterial pathogenesis, using selected examples and mechanisms of prokaryotic cell signaling, and advanced and high-throughput techniques used in prokaryotic molecular and cell biology.

BIOL 6407. Biochemistry for Molecular Biologists. 4 Hours.
Focuses on the interface between molecular biology, molecular genetics, and biochemistry. Concentrates on biochemical problems that molecular biologists are likely to find in their research. Includes examples of prokaryotic and eukaryotic (whenever available) systems. Experimental approaches are discussed for all topics. Seeks to enable students to develop a deep understanding of concepts in biological systems through reading and discussion of the primary literature.

BIOL 6966. Practicum. 1-4 Hours.
Provides eligible students with an opportunity for practical experience. May be repeated without limit.

BIOL 7000. Qualifying Exam. 0 Hours.
Provides eligible students with an opportunity to take the master’s qualifying exam.

BIOL 7243. Embryonic Stem Cells and Regeneration. 4 Hours.
Explores the biological basis for an understanding of embryonic stem cells and regeneration and their potential for curing a variety of diseases. Covers both theoretical and methodological topics. Student presentations and discussions constitute a large portion of the course.

BIOL 7303. Structural Biology. 4 Hours.
Offers in-depth analysis of principles and current literature of protein and/or cell structure and function.

BIOL 7304. Genome Structure and Function. 4 Hours.
Describes the structure and function of DNA, that is, nucleic acid chemistry, chromatin structure and its regulation, replication, and repair. Emphasis is on the importance of contemporary methodology in studying genomes from different organisms.

BIOL 7305. Advanced Immunology. 2 Hours.
Prepares, critically reviews, and discusses current concepts in immunological research within the context of the field of immunology.

BIOL 7382. Research Problem Solving. 2 Hours.
Discusses experimental design and analysis. Requires student presentations. May be repeated without limit.

BIOL 7383. Topics in Biochemistry Cell and Molecular Biology. 2 Hours.
Offers selected advanced topics in the area of biochemistry, cell, and molecular biology; topics vary from year to year. Requires student presentations. May be repeated without limit.

BIOL 7384. Topics in Integrative Biology. 2 Hours.
Offers selected advanced topics in the areas of ecology, systematics, evolution, physiology, and marine biology; topics vary from year to year. Requires student presentations. May be repeated without limit.

BIOL 7399. Research Problem Solving, Ethics, and Communication Skills. 4 Hours.
Focuses on research problem-solving skills, including formulation of hypotheses; experimental design, execution, and analysis; and research ethics. Offers instruction in scientific writing, including daily record keeping, grants and papers, and oral communication skills. Discusses the use and misuse of statistics and discusses responsibility to the public. Requires permission of instructor for those students not enrolled in biology.

BIOL 7966. Practicum. 1-4 Hours.
Provides elective credit for courses taken at other academic institutions. May be repeated without limit.

BIOL 7967. Directed Study. 1-4 Hours.
Offers independent work under the direction of members of the department on a chosen topic. Course content depends on instructor. May be repeated without limit.

BIOL 7978. Independent Study. 1-4 Hours.
Offers independent work under the direction of members of the department on a chosen topic. Course content depends on instructor. May be repeated without limit.

BIOL 7990. Thesis. 1-4 Hours.
Offers thesis supervision by members of the department. May be repeated without limit.

BIOL 7996. Thesis Continuation. 0 Hours.
Offers continuing thesis supervision by members of the department.
BIOL 8420. Biological Lab Rotation 1. 4 Hours.
Offers experience in biology research in a faculty research laboratory. Intended only for students who have not yet chosen a lab in which to carry out dissertation/thesis work.

BIOL 8421. Biological Lab Rotation 2. 4 Hours.
Offers a second semester of research experience in a different laboratory than that for BIOL 8420. Intended only for students who have not yet chosen a lab in which to carry out thesis work.

BIOL 8506. Bioinformatics Graduate Co-op Tutorial. 1 Hour.
Designed to complement learning during or after graduate co-op placement. Offers students an opportunity to participate in activities to integrate academic learning and experiential learning including written reflections and oral presentations. Requires approved graduate co-op. May be repeated without limit.

BIOL 8960. Exam Preparation—Doctoral. 0 Hours.
Offers the student the opportunity to prepare for the PhD qualifying exam under faculty supervision.

BIOL 8964. Co-op Work Experience. 0 Hours.
Provides eligible students with an opportunity for work experience. May be repeated without limit.

BIOL 8966. Practicum. 1-4 Hours.
Provides eligible students with an opportunity for practical experience. May be repeated without limit.

BIOL 8982. Readings. 1-4 Hours.
Offers readings from current literature on an area of interest to students and faculty. May be repeated without limit.

BIOL 8984. Research. 1-4 Hours.
Focuses on research methods and their application to a specific problem under the direction of a graduate faculty member. May be repeated without limit.

BIOL 8986. Research. 0 Hours.
Offers the student the opportunity to conduct full-time research. May be repeated without limit.

BIOL 9000. PhD Candidacy Achieved. 0 Hours.
Indicates successful completion of the doctoral comprehensive exam.

BIOL 9984. Research. 1-4 Hours.
Focuses on research methods and their application to a specific problem under the direction of a graduate faculty member. May be repeated without limit.

BIOL 9990. Dissertation. 0 Hours.
Offers theoretical and experimental research for the PhD degree. May be repeated once.

BIOL 9996. Dissertation Continuation. 0 Hours.
Offers dissertation supervision by members of the department. May be repeated without limit.