PHSC 1990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

PHSC 2000. Professional Development Co-op. 1 Hour.
Introduces the Bouvé Cooperative Education Program. Offers students an opportunity to develop job-search and career-management skills. Students perform assessments of their workplace skills, interests, and values and discuss how they impact personal career decisions. Offers students an opportunity to prepare a professional-style résumé, learn proper interviewing techniques, and gain an understanding of the opportunities available to them for co-op. Introduces career paths, choices, and career decision making. Familiarizes students with workplace issues relative to their field of study and presents the MyNEU COOL database in the job-search and referral process. Presents and discusses co-op policies, procedures, and expectations of the Bouvé Cooperative Education Program and co-op employers.

PHSC 2301. Human Physiology 1. 3 Hours.
Provides students with an understanding of the principles of physiology. Discusses physiological information mostly related to cardiovascular, respiratory, digestive, urinary, and endocrine systems. Focuses on the physiological mechanisms of the major organ systems. Physiological information is related to the specific areas of pharmacology.

PHSC 2302. Human Anatomy Lab. 1 Hour.
Accompanies PHSC 2301. Focuses on the anatomy of the major organ systems. Interactive CD-ROMs allow each student to study in-depth the structure of each organ system.

PHSC 2303. Human Physiology 2. 3 Hours.
Continues PHSC 2301. Provides students with an understanding of the principles of physiology. Discusses physiological information mostly related to cell physiology, muscle physiology, and physiology of the nervous system. Focuses on the physiological mechanisms of the major organ systems. Physiological information is related to the specific areas of pharmacology.

PHSC 2304. Human Physiology Lab. 1 Hour.
Accompanies PHSC 2303. Covers topics from the course through various experiments.

PHSC 2320. Biochemistry. 4 Hours.
Introduces the structures, functions, and metabolism of amino acids, proteins, carbohydrates, lipids, and nucleic acids. Discusses the mechanisms of enzyme reactions, enzyme kinetics, vitamins, biological oxidation-reduction reactions, and bioenergetics, as well as various inborn errors of metabolism.

PHSC 2330. Immunology. 3 Hours.
Provides students with an understanding of the principles, mechanisms, organs, cells, and molecules of the innate and adaptive immunity. Monoclonal antibodies, organ transplant immunity, hypersensitivity, tolerance, tumor immunity, autoimmunity, and immunodeficiencies are discussed in light of potential therapeutic interventions. Weekly journal club-style presentation of related assigned topic is required.

PHSC 2360. Medical Microbiology. 3 Hours.
Reviews the structure and physiology of bacteria, fungi, parasites, and viruses, and then surveys the members of each of these groups of organisms that commonly colonize and/or cause significant disease in humans. The survey focuses on human organ systems such as skin and mucous membranes, gastrointestinal, respiratory, and urinary tracts, central nervous system, blood and lymphatics, and others. When possible, demonstration cultures of microorganisms are made available to students, and computer study guides or Kodachrome slide sets are available for review.

PHSC 2550. Introduction to Health Science Research. 4 Hours.
Surveys research methods and topics relevant to health science research with the goal of engaging undergraduate students to commit to research training throughout at least one semester and possibly continuing throughout their undergraduate program. Exposes students to lectures addressing the benefits of a research experience and readings of original literature. Health science faculty from across the university present their lines of research focusing on projects that would be available to students. Seeks to familiarize students with use of the scientific method in addressing unsolved problems and to prepare them to select the most appropriate research laboratory to engage in research.

PHSC 2990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

PHSC 3411. Pharmaceutics 1. 4 Hours.
Develops an understanding of pharmaceutical dosage forms, with emphasis on solids, liquids, semisolids, parenterals, inhalation, and novel drug delivery systems. Combines the discussion of pharmaceutical products developed in industry and those compounded in local pharmacies. Focuses on application of mathematical principles and problem-solving skills in pharmaceutical compounding.

PHSC 3412. Pharmaceutics 2. 4 Hours.
Continues PHSC 3411. Examines the physical and chemical properties of the drug as it relates to pharmaceutical product development. Covers concepts of thermodynamics, colligative properties, ionic equilibriums and buffers, solubility, complexation and protein binding, reaction kinetics, mass transport, interfacial phenomena and dispersion, and rheology.

PHSC 3419. Pharmaceutics Laboratory. 1 Hour.
Formulates pharmaceutical dosage forms such as powders, capsules, solutions, suspensions, emulsions, ointments, gels, creams, lotions, and suppositories, and tests the quality of the products in the lab using approved methods of analysis. Also provides an understanding of the physical and chemical properties of drugs as they relate to formulation development through experimental observation of dissolution, stability, and effects of pH and co-solvent on solubility of drugs.
PHSC 3430. Pharmacokinetics and Biopharmaceutics. 3 Hours.
Focuses on the basic principles and methods of biopharmaceutics and pharmacokinetics. Covers the kinetics of drug absorption, distribution, metabolism, and excretion; linear and nonlinear pharmacokinetics; general concept of one- and two-compartment models with instantaneous (i.v. bolus), zero order (i.v. infusion), or first order (oral administration or i.m. injection) input; evaluation of bioavailability and investigation of the factors affecting drug availability; influence of the route of administration, dosage form, and regimen on bioavailability of drugs; bioequivalence study; multiple dosing kinetics; general approaches to dosage adjustment in renal disease; noncompartmental analysis; and pharmacokinetic-pharmacodynamic modeling.

PHSC 3990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

PHSC 4340. Pharmacology for the Health Professions. 4 Hours.
Provides the fundamentals of pharmacology to students entering the health professions. Topics include the general principles of drug action, drug distribution, and drug elimination, with attention to the development of reasoning skills necessary to identify, avoid, and solve practical drug-related problems. Drugs are presented according to therapeutic or functional classification.

PHSC 4501. Pharmacology/Medicinal Chemistry 1. 5 Hours.
Introduces the principles and basic concepts of pharmacology and the general mechanisms of drug action including drug receptor interactions. Discusses the major drug classes affecting the peripheral autonomic and central nervous systems including anxiolytics, sedative-hypnotics, anesthetics, anticonvulsants, neuroleptics, antidepressants, and antianemic agents. Considers therapeutic uses, mechanisms of drug action, and undesirable actions including side effects and adverse reactions.

PHSC 4502. Pharmacology/Medicinal Chemistry 2. 5 Hours.
Continues PHSC 4501. Covers the mechanisms of action, structure-activity relationships, therapeutic uses, and adverse effects of drugs including cardiovascular agents, hormones, anticancer drugs, antibiotics, and antiinflammatory agents.

PHSC 4600. Pharmacy Capstone. 4 Hours.
Acts as a final integrator of the major, general education, and experiential aspects of the student’s education. Expect students to demonstrate motivation and initiative and to work cooperatively with their faculty mentor, community partners, and fellow students (where applicable) in order to complete a comprehensive, high-quality scholarly work (e.g., a research project, educational project, administrative project, business plan, case report, or community-service learning project or professional manuscript) appropriate for dissemination to the university and professional community. The timeline for completion is set by the faculty mentor and agreed to by the individual or all members of the student group. May be repeated once.

PHSC 4850. Capstone for BS in Pharmaceutical Sciences. 4 Hours.
Designed to facilitate integration of major, general education, and experiential aspects of the individual student’s program of study with a focused scientific research experience under the mentorship of a faculty member. Offers students an opportunity to develop a research question, perform data collection and analysis, and satisfactorily complete a quality research report (detailing background; methods; results; discussion, including relevance to their pharmaceutical science career development; and references), followed by participation in a seminar on their work presented to the Northeastern community. In addition, students are strongly encouraged to present their findings at local, regional, national, and international professional meetings. Requires approval of director of pharmaceutical sciences BS program.

PHSC 4970. Junior/Senior Honors Project 1. 4 Hours.
Focuses on in-depth project in which a student conducts research or produces a product related to the student’s major field. Combined with Junior/Senior Project 2 or college-defined equivalent for 8-credit honors project. May be repeated without limit.

PHSC 4971. Junior/Senior Honors Project 2. 4 Hours.
Focuses on second semester of in-depth project in which a student conducts research or produces a product related to the student’s major field. May be repeated without limit.

PHSC 4990. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

PHSC 4991. Research. 4 Hours.
Extends current knowledge or offers novel insights through faculty-directed and supervised individual undergraduate research or creative projects. The project must be designed in concert with and obtain formal prior approval from relevant faculty and program director. May be repeated without limit.

PHSC 4992. 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.

PHSC 4993. 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.

PHSC 4994. Internship. 4 Hours.
Offers students an opportunity for internship work. May be repeated without limit.

PHSC 4995. Practicum. 1-4 Hours.
Offers eligible students an opportunity for practical experience. May be repeated without limit.

Introduces new students in the Pharmaceutical Science Graduate Program to important concepts in medicinal and combinatorial chemistry as they relate to drug discovery, and a brief overview of pharmacology, drug metabolism, pharmacokinetics, and toxicology. Also introduces the major drug receptor families and their signaling pathways.

PHSC 5200. Advanced Immunology and Immunological Therapies. 2 Hours.
Offers an interactive course about molecular principles of immunity and ways to manipulate it. Provides instructive overview of molecular and cellular bases of the immunological diseases. Highlights the problems of modern clinical immunology and immunotherapies. Summarizes the molecular and cellular mechanisms by which the immune system protects the host from disease. Studies clinical cases of examples of the failure of immunity to some infections and, on the other hand, how inappropriate immune responses can themselves cause disease, such as with allergy and autoimmunity. Describes the pharmacological and physiological regulation of immune response and explains biotechnological approaches to develop new effective vaccines and immunotherapies.
PHSC 5300. Pharmaceutical Biochemistry. 2 Hours.
Offers students an opportunity to obtain an understanding of the principles of physiological chemistry. Focuses in-depth on the major topics of physiological chemistry, including general chemistry and biomolecules, peptide synthesis and protein structure, carbohydrates and nucleic acids, thermodynamics and kinetics of molecular interactions, and colloids and micelles. Relates biochemical information to the specific areas of pharmacology, pharmaceutics, and drug discovery/development.

PHSC 5305. Professional Development for Pharmaceutical Sciences. 1 Hour.
Introduces and examines the goals, expectations, policies, and procedures of the Masters’ in Pharmaceutical Sciences internship program and professionalism in the field. Discusses the role and involvement of internship employers. Offers students an opportunity to develop job search and career management skills; assess their workplace skills, interests, and values; discuss how those qualities impact career decisions; prepare a professional resume; and learn proper interviewing techniques. Issues of ethics and professionalism are designed to inform students of issues they will face in the pharmaceutical field. Content of this course is geared to students’ participation in the internship program and overall professional development in pharmaceutical sciences.

PHSC 5310. Cellular Physiology. 2 Hours.
Focuses in-depth on the major cellular physiological mechanisms, including physiology of the cell membrane, ion channels and transport phenomena, energy production, signal transduction, synapses, and physiological processes in the cytosol. Relates physiological information on the specific areas of pharmacology, pharmaceutics, and drug discovery/development. Offers students an opportunity to obtain an understanding of the principles of cellular physiology.

PHSC 5360. Anti-Infectives. 4 Hours.
Reviews the structure and physiology of bacteria, fungi, and viruses and surveys significant organisms of medical importance. Introduces specific antibiotic, antifungal, and antiviral agents and classes of agents once a foundation of knowledge of the microorganisms that cause disease is established. Discusses concepts of pharmacology, pharmacokinetics, antimicrobial resistance, pharmacodynamics of antimicrobial agents, and spectra of activity.

PHSC 5400. Principles of Drug Design. 3 Hours.
Studies important aspects of drug discovery and development with a focus on drug design. Covers basic organic medicinal chemistry concepts and seeks to build students’ skills in lead compound discovery, structure-activity relationship studies, and lead optimization strategies. Topics include the fundamentals of pharmacology, pharmacokinetics, and pharmacodynamics of therapeutic agents relevant to the drug-structure optimization. These skills often help develop a strong foundation in the concepts that govern the multidisciplinary process of drug discovery. Uses lectures and peer-reviewed seminar presentations to help students to incrementally increase their knowledge required to identify new, marketable therapeutic agents. Requires organic or medicinal chemistry at the undergraduate level.

PHSC 5500. Repurposing Drugs for Cancer Immunotherapies. 2 Hours.
Offers a multidisciplinary course targeted to students interested in recent advances in biomedical research, clinical practice, and personalized medicine as related to cancer immunotherapies. Describes current promises and disappointments with cancer immunotherapies and recent FDA drug approvals for personalized cancer therapies. Explains the role of immunological and physiological negative regulators of antitumor and tumor biology as needed. Explains underlying principles of immunology, biochemistry, genetics, and preclinical and clinical studies when introducing new concepts. Assigned detailed study of specific areas and discussion of assigned papers are designed to complement classroom material.

PHSC 5555. Pharmaceutical Toxicology. 3 Hours.
Covers fundamental concepts of toxicology and technical methods in toxicology along with comprehensive analysis of both in-vitro and in-vivo toxicity in drug discovery and development. Through lectures given by experts in various fields in toxicology on several topics required for specialized work in research, industrial, and clinical settings, offers students an opportunity to become familiar with methods and analyses including in-vitro and in-vivo toxicity assessments and toxicokinetic-toxicodynamic models and analyses. Includes mechanistic basis of toxicity, methods of toxicological analysis, and case studies pertinent to topics. Requires undergraduate physiology or biochemistry.

PHSC 5976. 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.

PHSC 5978. 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.

PHSC 5984. Research. 1-4 Hours.
Offers an opportunity to conduct research under faculty supervision. May be repeated without limit.

PHSC 6210. Drug Design, Evaluation, and Development. 2 Hours.
Teaches students the concepts of using immunological, genomic, and proteomic techniques to find novel drug targets. Also introduces the concepts of drug targeting and dosage forms, in vivo/in vitro drug screening, and the importance of pharmacogenetics to explain variability in drug reactions.

PHSC 6212. Research Skills and Ethics. 1 Hour.
Teaches students the basics of laboratory safety, safekeeping laboratory data, and the process of writing a grant proposal. Also, case studies explore the concepts of data distortion or fabrication, conflicts of interest, confidentiality, ethical aspects of peer review, and the attribution of credit in science.

PHSC 6214. Experimental Design and Biostatistics. 2 Hours.
Discusses fundamental principles of experimental design and statistical analysis, with emphasis on clinical research. Topics include descriptive statistics, hypothesis testing, analysis of variance, correlation, regression, chi-square test, and nonparametric methods.

PHSC 6216. Human Physiology and Pathophysiology. 2 Hours.
Introduces major topics in human physiology, emphasizing knowledge essential to health-related laboratory research. Topics include neurophysiology, immunology, cardiovascular, respiratory, renal, and gastrointestinal physiology and endocrinology.
PHSC 6218. Biomedical Chemical Analysis. 2 Hours.
Prepares the modern reagents, techniques, and instrumentation used to analyze biological samples and purify their components (that is, drugs, metabolites, hormones, macromolecules, organelles, and cells) in health and disease. Emphasizes basic concepts and mechanisms at the chemical level, and applications to human samples.

PHSC 6222. The Chemistry and Biology of Drugs of Abuse. 2 Hours.
Provides an interdisciplinary introduction to substance abuse, including the medicinal chemistry and neurobiology of drugs that act through the opioid, dopamine, acetylcholine, and cannabinoid systems. Compares and contrasts neurochemical mechanisms that are common to many addictive agents and those that are specific to individual drug classes. Highlights the involvement of the brain dopamine system and differences and discusses similarities between the pharmacology of abused and therapeutic drugs, together with the development of medications for treating drug dependence. Includes lectures by experts on particular topics of their own recent research. Introduces students to key aspects of biological and chemical research as they pertain to drug abuse and its treatment.

PHSC 6224. Behavioral Pharmacology and Drug Discovery. 2 Hours.
Designed to prepare students to understand the advantages, shortcomings, and pitfalls of the use of live, behaving animals in drug discovery. Covers an in-depth analysis of ethical issues in animal research, as well as aspects of animal behavioral models, behavior and brain biochemistry, and methods of behavioral analysis. Specific topics include psychopharmacology, fear and anxiety; pain and stress; depression and reward; general arousal and tolerance; drug abuse and habitual behaviors. The ways in which animal behaviors can be described in a quantitative manner and the effects of medications and abused drugs quantified and related to human diseases and drug responses are an important component of the course.

PHSC 6226. Imaging in Medicine and Drug Discovery. 2 Hours.
Designed to prepare students to understand modern noninvasive medical imaging modalities, principally positron emission tomography (PET) and magnetic resonance imaging (MRI), used in metabolic and functional studies. Reviews the basic science of magnetic resonance and radioactivity and radiation measurement, as well as tracer kinetics, but concentrates on applications. Covers a survey of clinical radiological studies; clinical and preclinical human drug discovery and development research involving imaging; and the development and uses of radiopharmaceuticals and other contrast agents for imaging modalities, including X-rays and ultrasound as well as PET and MRI.

PHSC 6280. Immunobiotechnology. 2 Hours.
Presents the basic elements of immunopathology, reviewing the components and function of the immune system. Covers the disorders of the complement system, the biologic mechanisms of immunologically induced tissue injury (hypersensitivity reactions), autoimmunity, and immunodeficiency. Considers the immunological features of cancer and transplant rejection.

PHSC 6290. Biophysical Methods in Drug Discovery. 2 Hours.
Provides an interdisciplinary introduction to biophysical methods used in modern drug discovery, including hit generation and lead optimization. Emphasizes key experimental methods, including nuclear magnetic resonance (NMR) spectroscopy and X-ray crystallography, as well as computer modeling as applied to ligand- and structure-based drug design. Includes lectures by experts on related topics from their recent drug-discovery research. Presented under the auspices of the Center for Drug Discovery. Requires permission of instructor for students of junior or senior standing.

PHSC 6300. Pharmaceutical Science Seminar. 1 Hour.
Teaches students to evaluate critically the scientific literature in a journal club format. Several sections may be offered each semester to accommodate different specializations or interest groups. May be repeated without limit.

PHSC 6314. Special Topics of Pharmaceutical Science. 2 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.

PHSC 6401. Pharmaceutical Science Internship. 1 Hour.
Offers an experiential component of the graduate curriculum that fosters professional development through internship in drug discovery, development, and/or regulatory affairs in a pharmaceutical or biotechnology company. Requires students to work in a company for a minimum of twenty hours per week. Offers students an opportunity to engage in pharmaceutical science research or to work in an environment outside the University but under the supervision of a faculty instructor. May be taken in any semester. May be repeated up to two times.

PHSC 6760. Doctoral Pharmaceutical Science Research 1. 2 Hours.
Offers PhD research in preparation for thesis proposal.

PHSC 6761. Doctoral Pharmaceutical Science Research 2. 2 Hours.
Offers PhD research in preparation for thesis proposal.

PHSC 6810. Pharmaceutical Science Colloquium. 1 Hour.
Requires students to present one formal seminar on their research. This presentation is open to all those interested.

PHSC 6962. Elective. 1-4 Hours.
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

PHSC 6964. Co-op Work Experience. 0 Hours.
Provides eligible students with an opportunity for work experience. May be repeated without limit.

PHSC 6984. Pharmaceutical Science Research. 2 Hours.
Offers students laboratory research under the guidance of an adviser. May be repeated once for up to 4 total credits.

PHSC 6990. Thesis. 2 Hours.
Offers research/experimental work for master’s thesis. Students may register twice. May be repeated once.

PHSC 6996. Thesis Continuation. 0 Hours.
Offers continued registration while student completes master’s thesis or other research project to meet the research requirement in pharmaceutical science.

PHSC 7010. Pharmaceutical Sciences Laboratory. 4 Hours.
Offers a hands-on graduate laboratory course that introduces students to the investigative approaches and laboratory methods used in contemporary pharmaceutical sciences research. Laboratory exercises have a practical relationship to essential techniques in modern drug discovery, drug targeting and delivery, and determining mechanisms of drug action. These exercises cover basic laboratory skills, the rationale for and application of standard laboratory methods, training in the use of equipment and techniques central to pharmaceutical sciences research, how to maintain a laboratory notebook, statistical analysis and interpretation of data, and how to present research results in technical laboratory reports.
PHSC 7020. Scientific Writing: Thesis Proposal. 2 Hours.
Presents the principles of writing a proposal based on the NIH R01 grant proposal template used by the department. Participants develop their own proposal in collaboration with their faculty advisor or the immediate project supervisor designated by their faculty advisor (the project principle investigator). Offers students an opportunity to meet with their own project principle investigators to develop content and map out the project aims and experimental design and to produce a revised draft of their thesis proposal. Each student must have initiated MS or PhD thesis research and have some preliminary data; PhD students must have passed their qualifying exam; MS students must petition the graduate committee in writing for permission to enroll.

PHSC 7030. Working with Radioactive Drugs. 1 Hour.
Offers students an opportunity to learn through a combination of lectures, readings, and hands-on laboratory work how to conduct experiments with radioactive drugs and other radio-labeled compounds in a manner that is safe, that is compliant with federal and state regulations, and that generates scientific data of high quality.

PHSC 7990. Thesis. 1-4 Hours.
Offers preparation of PhD thesis proposal and proposal defense before thesis committee. Requires qualifying examination. May be repeated without limit.

PHSC 8940. Doctoral Training and Research. 1 Hour.
Intended to show full-time status for pharmaceutical science PhD students in the semester in which they are taking the comprehensive exam. In addition to successfully completing the comprehensive exam, students are expected to perform research in preparation for the doctoral proposal; the grade for this course documents successful performance. Restricted to pharmaceutical science PhD students wishing to establish doctoral candidacy.

PHSC 8986. Doctoral Full-Time Research. 0 Hours.
Expects student to conduct full-time research in an adviser’s laboratory. May be repeated without limit.

PHSC 9000. Comprehensive Exam. 0 Hours.
Indicates successful completion of the doctoral comprehensive exam.

PHSC 9681. Doctoral Proposal. 2 Hours.
Offers preparation of PhD dissertation proposal and proposal defense before dissertation committee. Requires passing of comprehensive exam. May be repeated without limit.

PHSC 9990. Dissertation. 3 Hours.
Offers research/experimental work for PhD thesis. Students may register three times. May be repeated up to two times.

PHSC 9996. Dissertation Continuation. 0 Hours.
Offers continuation of PhD dissertation research. May be repeated without limit.