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

PHSC 2100. Lab Research Rotation. 4 Hours.
Offers students an opportunity to conduct laboratory research under the direct supervision of a laboratory mentor, generally a faculty member or laboratory director, gain experience in research techniques, and develop good laboratory practices as they learn about research topics under investigation in the laboratory of their choice. Students attend seminars, departmental events, and other activities relevant to the mentor's laboratory. The time commitment is at least eight hours a week. Mentor expectations and grading criteria are decided upon between the student and the mentor prior to the start of the rotation and must be approved by the course director. Students prepare a presentation that encompasses the research performed by the student that includes description, experimental design, data generated, data interpretation, and discussion of their research project.

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 2400. Research Ethics for Beginning Health Scientists. 4 Hours.
Explores various dimensions of ethical research. Introduces ethical foundations and controversies that are central to understanding and developing appropriate ethical frameworks for engaging in research. Requires students to work collaboratively to carefully develop essential skills for ethical analysis and evaluation of professional code of conduct concerns.

PHSC 2650. 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 antiinflammatory 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. Expects 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 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 4997. Senior Thesis. 4 Hours.
Offers students an opportunity to prepare an undergraduate thesis under faculty supervision.

PHSC 4998. Senior Thesis Continuation. 4 Hours.
Offers students an opportunity to continue preparing an undergraduate thesis under faculty supervision.

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 5102. Concepts in Pharmaceutical Science 2. 2 Hours.
Presents key concepts and challenges of drug design, development, and evaluation. Integrates the principles of drug design, development, and delivery in a discussion of both small-molecule formulations and biologics. Contextualizes the hallmarks along the path of preclinical drug design to clinical translation. Components of the course include Team-Based Learning (TBL) and professionalism. The TBL sessions offer students an opportunity to work on course-related team applications and include graded peer evaluations.

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 resumé; 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. Examines 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
 Toxicty, 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 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 6213. Ethical Problems in Health Sciences Research. 1 Hour.
Focuses on a series of cases that raise ethical and professional code
of conduct concerns and engages with them collaboratively and
carefully to develop essential skills for ethical analysis and evaluation.
Scientific practice presents researchers and citizens with myriad ethical
challenges. Engaging with those ethical challenges in ways that help
yield the benefits of research while respecting ethical boundaries is
furthered by not only understanding ethical frameworks but by carefully
analyzing and evaluating ethical concerns in context.

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.
Presents 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 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 6920. 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 adviser 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 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.
Expect students to conduct full-time research in an adviser's laboratory. May be repeated without limit.

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 once.

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