

# Biotechnology, MS

## Overview

Northeastern's Master of Science in Biotechnology is a professional master's program, an innovative, nonthesis graduate degree. It combines advanced interdisciplinary training in biotechnology, biology, chemistry, and pharmaceutical sciences with the development of high-value business skills critical to success in today's dynamic workplace. This program is designed to prepare graduates to innovate, collaborate, and lead as research, managerial, or technical professionals in a wide range of biotechnology specialties. The two-year program offers students the possibility to pursue one of ten concentrations to further their knowledge in a specific topical area of the field.

## Concentrations

### AGRICULTURAL BIOTECHNOLOGY CONCENTRATION

The agricultural concentration goes beyond the production of biological drugs and focuses on the key agricultural biotechnology (agritech) principles and methods used today. Students have an opportunity to learn the principles of agritech and the role they play in the concepts and fundamentals of agriculture today. The concentration addresses plant, animal, food, and ecological biotechnology. The learning of the students is reinforced by both lecture courses and project-driven laboratory experience that provides hands-on learning of modern agricultural methodologies.

### BIODEFENSE CONCENTRATION

The biodefense concentration is designed to prepare students for the initial homeland biodefense and bioterrorism response. Students have an opportunity to learn the microbiology and epidemiology of biological agents that are potential threats, identify and propose countermeasures, and develop expertise in response and recovery strategies and policies. The learning combines the foundational biotechnology courses with case-based and hands-on bioethical, biowarfare, and bioterrorism courses.

### BIOPHARMACEUTICAL TECHNOLOGIES AND ANALYTICS CONCENTRATION

The biopharmaceutical technologies and analytics track focuses on structures, variants and activities of biological molecules as well as how to convert purified proteins to biopharmaceutical drug products that are compatible for clinical use. Students learn the diversity of molecular forms derived from biological products, techniques to analyze and characterize these forms, and the impact of these structural changes on the safety and efficacy of biopharmaceuticals. The track addresses design of product formulation, development and implementation of drug product manufacturing processes, and relevant process technology, such as aseptic operations and freeze-drying, needed for drug product manufacturing. This is accomplished through both lecture courses and project-driven laboratory experiences that utilize analytical techniques and provide hands-on learning of formulation design and drug product process development.

### BIOTECHNOLOGY OPERATIONS CONCENTRATION

The biotechnology operations track is an operationally inclusive concentration that offers relevant insights to the inner workings of a biotech company while preparing students for new entry or promotions to a variety of biotech functions. Students learn the principles of quality, regulatory science, process science and manufacturing, while integrating business and management skills with the science of biotechnology. The track covers the science behind compliance and the principles and practices of state-of-the-art biopharmaceutical manufacturing and quality operations, enabling students to move across positions in discovery, clinical operations, manufacturing, quality, regulatory affairs, and consulting for operations and operational strategy and/or remediations.

### GORDON INSTITUTE OF ENGINEERING LEADERSHIP

#### MASTER'S DEGREE IN BIOTECHNOLOGY WITH GRADUATE CERTIFICATE IN ENGINEERING LEADERSHIP

Students may complete a Master of Science in Biotechnology in addition to earning a Graduate Certificate in Engineering Leadership (<https://catalog.northeastern.edu/graduate/engineering/multidisciplinary/engineering-leadership-graduate-certificate/>). Students must apply and be admitted to the Gordon Engineering Leadership Program in order to pursue this option. The certificate program requires fulfillment of the 16-semester-hour curriculum required to earn the Graduate Certificate in Engineering Leadership, which includes an industry-based challenge project with multiple mentors. The integrated 42-semester-hour master's degree and certificate requires 26 hours of biotechnology coursework.

## Program Requirements

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- Concentrations and course offerings may vary by campus and/or by program modality. Please consult with your advisor or admissions coach for the course availability each term at your campus or within your program modality.
  - Certain options within the program may be *required* at certain campuses or for certain program modalities. Please consult with your advisor or admissions coach for requirements at your campus or for your program modality.
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Complete all courses and requirements listed below unless otherwise indicated.

## Core Requirements

Code	Title	Hours
<b>Required Core</b>		
BIOT 5120	Foundations in Biotechnology	3
BIOT 5145	Biotechnology Lab Skills	1
BIOT 5219	The Biotechnology Enterprise	2
BIOT 5401	Scientific Communication and Problem Solving in Biotechnology	3
BIOT 5621	Protein Principles in Biotechnology	3
BIOT 5630	Cell Culture Applications for Biopharmaceuticals	2
BIOT 5750	Molecular Approaches in Biotechnology	3
BIOT 6214	Experimental Design and Biostatistics	2
BIOT 7245	Biotechnology Applications Laboratory	3
or BIOT 7246	Molecular Technologies Practicum	
<b>Electives</b>		
<b>Co-op and Experiential Learning</b>		
BIOT 6500	Professional Development for Co-op	0
Select one of the following options:		3
Option 1:		
BIOT 6964	Co-op Work Experience	
Complete 3 semester hours from the Electives list. (p. 4)		
Option 2:		
BIOT 7001	Managing Innovation in Biotechnology <sup>1</sup>	

<sup>1</sup> The option of BIOT 7001 Managing Innovation in Biotechnology is not available at all campus locations. Please refer to your advisor or admissions coach for course availability each semester at your campus location.

## Concentration or Electives Option

A concentration is not required. Students may complete the electives option in lieu of a concentration.

- Agricultural Biotechnology (p. 2)
- Biodefense (p. 3)
- Biopharmaceutical Technologies and Analytics (p. 3)
- Biotechnology Operations (p. 3)
- Electives (p. 4)

## Program Credit/GPA Requirements

34 total semester hours required

Minimum 3.000 GPA required

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### AGRICULTURAL BIOTECHNOLOGY CONCENTRATION

Code	Title	Hours
<b>Required</b>		
BIOT 5810	Cutting-Edge Applications in Molecular Biotechnology	3
BIOT 6100	Agricultural Biotechnology	3
<b>Elective</b>		
In consultation with advisor, complete a minimum of 3 semester hours from the following:		3
BIOT 5850	Higher-Order Structure Analytics	
BIOT 5225	Managing and Leading a Biotechnology Company	
ENVR 5150	Climate and Atmospheric Change	
ENVR 5190	Soil Science	
ENVR 5210	Environmental Planning	
ENVR 5350	Sustainable Energy and Climate Solutions	
ENVR 5670	Global Biogeochemistry	

ENVR 5800	Climate Adaptation and Nature-Based Solutions	
ENVR 6150	Food Security and Sustainability	
<b>BIODEFENSE CONCENTRATION</b>		
<b>Code</b>	<b>Title</b>	<b>Hours</b>
<b>Required</b>		
BIOT 6600	Agents of Bioterrorism	3
BIOT 6610	Biosecurity and Bioterrorism	3
<b>Elective</b>		
In consultation with advisor, complete a minimum of 3 semester hours from the following:		3
BIOT 5810	Cutting-Edge Applications in Molecular Biotechnology	
PPUA 6532	Building Resilience into Local Government	
PHTH 5230	Global Health	
PHTH 5202	Introduction to Epidemiology	
PHTH 5212	Public Health Administration and Policy	
SCHM 6223	Managing Healthcare Supply Chain Operations	
<b>BIOPHARMACEUTICAL TECHNOLOGIES AND ANALYTICS</b>		
<b>Code</b>	<b>Title</b>	<b>Hours</b>
<b>Required</b>		
BIOT 5640	Drug Product Processes for Biopharmaceuticals	3
BIOT 5700	Molecular Interactions of Proteins in Biopharmaceutical Formulations	3
<b>Elective</b>		
In consultation with advisor, complete a minimum of 3 semester hours from the following:		3
BIOT 6320	Design and Development of Biopharmaceuticals	
BIOT 5910	Vaccines and Immunization	
BIOT 5930	Molecular Tools for Vaccine Design	
BIOT 5850	Higher-Order Structure Analytics	
BIOT 5225	Managing and Leading a Biotechnology Company	
CHEM 5550	Introduction to Glycobiology and Glycoprotein Analysis	
CHEM 5617	Protein Mass Spectrometry Laboratory	
<b>BIOTECHNOLOGY OPERATIONS</b>		
<b>Code</b>	<b>Title</b>	<b>Hours</b>
<b>Required</b>		
BIOT 6320	Design and Development of Biopharmaceuticals	3
BIOT 6290	Foundation in Quality for Biotechnology	3
<b>Elective</b>		
In consultation with advisor, complete a minimum of 3 semester hours from the following:		3
<i>Process Sciences Focus</i>		
BIOT 5560	Bioprocess Fundamentals	
BIOT 5635	Downstream Processes for Biopharmaceutical Production	
<i>Manufacturing Quality Operations Focus</i>		
BIOT 6300	Pharmaceutical Microbiology	
BIOT 6340	Sterile Manufacturing Operations	
BIOT 5330	Drug Safety and Immunogenicity	
<i>Regulatory Science Focus</i>		
BIOT 5340	Introduction to Biotherapeutic Approvals	
BIOT 5500	Concepts in Regulatory Science	
<i>Enterprise Focus</i>		
BIOT 5225	Managing and Leading a Biotechnology Company	
BIOT 5228	Planning and Executing Biotechnology Projects	

**ELECTIVES OPTION**

<b>Code</b>	<b>Title</b>	<b>Hours</b>
Complete 9 semester hours from the Electives list. (p. 4)		9

**Electives List**

<b>Code</b>	<b>Title</b>	<b>Hours</b>
Complete electives from the following list and/or 1 SH BUSN graduate-level courses. Electives not on this list may be taken with academic advisor approval.		
BINF 6200	Bioinformatics Programming	
BINF 6308	Bioinformatics Computational Methods 1	
BIOE 5430	Principles and Applications of Tissue Engineering	
BIOL 5543	Stem Cells and Regeneration	
BIOL 5549	Inventions in Microbial Biotechnology	
BIOL 5573	Medical Microbiology	
BIOL 5581	Biological Imaging	
BIOL 5583	Immunology	
BIOL 5587	Comparative Neurobiology	
BIOL 5591	Advanced Genomics	
BIOL 5597	Immunotherapies of Cancer and Infectious Disease	
BIOL 6381	Ethics in Biological Research	
BIOT 5220	The Role of Patents in the Biotechnology Industry, Past and Future	
BIOT 5225	Managing and Leading a Biotechnology Company	
BIOT 5227	Launching Your Science: Biotechnology Entrepreneurship	
BIOT 5330	Drug Safety and Immunogenicity	
BIOT 5340	Introduction to Biotherapeutic Approvals	
BIOT 5400	Scientific Information Management for Biotechnology Managers	
BIOT 5500	Concepts in Regulatory Science	
BIOT 5560	Bioprocess Fundamentals	
BIOT 5635	Downstream Processes for Biopharmaceutical Production	
BIOT 5640	Drug Product Processes for Biopharmaceuticals	
BIOT 5700	Molecular Interactions of Proteins in Biopharmaceutical Formulations	
BIOT 5810	Cutting-Edge Applications in Molecular Biotechnology	
BIOT 5820	Cellular Therapies	
BIOT 5850	Higher-Order Structure Analytics	
BIOT 5910	Vaccines and Immunization	
BIOT 5920	Foundations in Vaccine Regulatory Science	
BIOT 5930	Molecular Tools for Vaccine Design	
BIOT 6100	Agricultural Biotechnology	
BIOT 6300	Pharmaceutical Microbiology	
BIOT 6310	CGMP Statutes and Regulation	
BIOT 6320	Design and Development of Biopharmaceuticals	
BIOT 6340	Sterile Manufacturing Operations	
BIOT 6600	Agents of Bioterrorism	
BIOT 6610	Biosecurity and Bioterrorism	
CHEM 5550	Introduction to Glycobiology and Glycoprotein Analysis	
CHEM 5617	Protein Mass Spectrometry Laboratory	
CHEM 5621	Principles of Chemical Biology	
CHEM 5625	Chemistry and Design of Protein Pharmaceuticals	
CHEM 5638	Molecular Modeling	
CHME 7340	Chemical Engineering Kinetics	
DA 5020	Collecting, Storing, and Retrieving Data	
DA 5030	Introduction to Data Mining/Machine Learning	
EMGT 5220	Engineering Project Management	
ENTR 6210	Managing Operations in Early Stage Ventures	

ENTR 6211	Entrepreneurship: Services and Retail Business Creation
ENTR 6212	Business Planning for New Ventures
ENTR 6219	Financing Ventures from Early Stage to Exit
ENTR 6241	Entrepreneurial Marketing and Selling
ENTR 6250	Lean Design and Development
ENVR 6102	Environmental Science and Policy Seminar 2
HINF 5105	The American Healthcare System
HINF 6201	Organizational Behavior, Work Flow Design, and Change Management
INNO 6225	Acquisitions, Alliances, and Growth
INSH 5301	Introduction to Computational Statistics
INTB 6200	Managing the Global Enterprise
INTB 6212	Cultural Aspects of International Business
MGMT 6213	Managing Ethics in the Workplace and Marketplace
MGMT 6223	Strategic Decision Making for Healthcare Professionals
MGMT 6225	Sustainability and Leadership
MGSC 6200	Information Analysis
NNMD 5270	Foundations in Nanomedicine: Therapeutics
NNMD 5470	Nano/Biomedical Commercialization: Concept to Market
NNMD 5272	Nanomedicine Seminar
NNMD 5370	Nanomedicine Research Techniques
PHSC 5212	Research Skills and Ethics
PHSC 5300	Pharmaceutical Biochemistry
PHSC 5500	Repurposing Drugs for Cancer Immunotherapies
PHSC 5560	Nanotoxicity
PHSC 6224	Behavioral Pharmacology and Drug Discovery
PHSC 6290	Biophysical Methods in Drug Discovery
PHSC 7010	Pharmaceutical Sciences Laboratory
PHTH 5320	Grant Writing in Public Health
POLS 7341	Security and Resilience Policy
POLS 7346	Resilient Cities
POLS 7343	Counterterrorism
PPUA 5261	Dynamic Modeling for Environmental Decision Making
PPUA 5262	Big Data for Cities
PPUA 5263	Geographic Information Systems for Urban and Regional Policy
PPUA 6532	Building Resilience into Local Government
STRT 6200	Strategic Decision Making in a Changing Environment