

Bioengineering, MSBioE (Boston)

Bioengineering is engineering in a biological context such as the human body, an ecosystem, or a bioreactor. In every case, the interface between engineered and biological systems places unique constraints on the design and implementation of devices, instruments, or implants. These depend on the properties of the biological system involved and the functionality that is being created.

The interface of engineering and medicine as embodied in bioengineering will be one of the most exciting endeavors and greatest adventures of the 21st century. Job opportunities are expected to expand dramatically with a focus on development of entirely new classes of products, instrumentation, and implants. The impact to human health will be extraordinary.

Bioengineering is intrinsically multidisciplinary and it is essential that students learn the languages used by multidisciplinary teams. To that end, our curriculum is structured around a core of six courses that analyze biological systems from every possible quantitative point of view. On the completion of the core, students select one of four concentrations, which provides the opportunity to develop a deep level of expertise in a specific area of bioengineering.

Bioengineering students will have unique opportunities in the classroom, research labs, and experiential learning. The projects that they may be able to contribute to include bio-bandages that monitor bacterial growth or that help damaged ligaments heal faster; sheets of cells folded like origami to form a working kidney; and new materials that—like a leaf in the sun—automatically sense and adapt to changes in the environment.

Our graduate program includes four concentrations, including:

- Biomechanics and Mechanobiology
- Biomedical Devices and Bioimaging
- Molecular, Cell, and Tissue Engineering
- Systems, Synthetic, and Computational Bioengineering

Graduate Certificate Options

Students enrolled in a master's degree have the opportunity to also pursue one of the many engineering graduate certificate options in addition to or in combination with the MS degree. Students should consult their faculty advisor regarding these options (<https://catalog.northeastern.edu/graduate/engineering/graduate-certificate-programs/>).

GORDON INSTITUTE OF ENGINEERING LEADERSHIP

Master's Degree in Bioengineering with Graduate Certificate in Engineering Leadership

Students may complete a Master of Science in Bioengineering 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 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 33-semester-hour degree and certificate will require 17 hours of advisor-approved bioengineering technical courses. For students who concurrently enroll in the Graduate Certificate in Engineering Leadership, 16 semester hours of the certificate coursework may be applied to the requirements of the coursework option of any concentration of this program.

Program Requirements

Complete all courses and requirements listed below unless otherwise indicated.

Note: This major requires a concentration: biomechanics and mechanobiology; biomedical devices and bioimaging; molecular, cell, and tissue engineering; or systems, synthetic, and computational bioengineering. Consult your college administrator.

Core Requirements

Code	Title	Hours
Seminar		
BIOE 7390	Seminar ¹	0
Required Core		
A grade of C or higher is required in each course:		
BIOE 6000	Principles of Bioengineering ¹	1
BIOE 6100	Medical Physiology	4

Concentrations

Complete one of the following four concentrations:

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- Biomechanics and Mechanobiology (p. 2)
- Biomedical Devices and Bioimaging (p. 3)
- Molecular, Cell, and Tissue Engineering (p. 4)
- Systems, Synthetic, and Computational Bioengineering (p. 5)

Optional Co-op Experience

Code	Title	Hours
Complete the following (students must complete ENCP 6100 to qualify for co-op experience):		
ENCP 6100	Introduction to Cooperative Education	1
ENCP 6964	Co-op Work Experience	0
or ENCP 6954	Co-op Work Experience - Half-Time	
or ENCP 6955	Co-op Work Experience Abroad - Half-Time	
or ENCP 6965	Co-op Work Experience Abroad	

Program Credit/GPA Requirements

32 total semester hours required (33 with optional co-op; some concentrations may require additional hours)

Minimum 3.000 GPA required

- ¹ Principles of Bioengineering (BIOE 6000) and Seminar (BIOE 7390) are not required for students in a PlusOne bioengineering pathway, but students must successfully complete a total of 32 semester hours.

CONCENTRATION IN BIOMECHANICS AND MECHANOBIOLOGY

Code	Title	Hours
Required Coursework		
A grade of C or higher is required.		
Complete two of the following:		8
BIOE 5630	Physiological Fluid Mechanics	
BIOE 5640	Computational Biomechanics	
BIOE 5650	Multiscale Biomechanics	
BIOE 5660	Integrative Mechanobiology	
ME 5665	Musculoskeletal Biomechanics	
Complete one of the following options:		20
<i>Coursework Option</i>		
Complete 20 semester hours from the course list. Any course on the required course list not used toward the core requirement may also be taken.		
<i>Project Option</i>		
BIOE 7945	Master's Project	
Complete 16 semester hours from the course list. Any course on the required course list not used toward the core requirement may also be taken.		
<i>Thesis Option</i>		
BIOE 7945	Master's Project	
BIOE 7990	Thesis	
Complete 12 semester hours from the course list. Any course on the required course list not used toward the core requirement may also be taken.		
In addition to completing the thesis course, students must successfully complete the thesis submission process, including securing committee and Graduate School of Engineering signatures and submission of an electronic copy of their MS thesis to ProQuest.		
Course List		
BIOE 5115	Dynamical Systems in Biological Engineering	
BIOE 5440	The Cell as a Machine	
BIOE 5520	Bioengineering Design for Robotic Rehabilitation	
BIOE 5630	Physiological Fluid Mechanics	
BIOE 5640	Computational Biomechanics	
BIOE 5650	Multiscale Biomechanics	

BIOE 5660	Integrative Mechanobiology
BIOE 5770	Machine Learning Methods in Biology and Health
BIOE 5820	Biomaterials
or CHME 5631	Biomaterials Principles and Applications
BIOL 5601	Multidisciplinary Approaches in Motor Control
CHME 5632	Advanced Topics in Biomaterials
EECE 7200	Linear Systems Analysis
EECE 7203	Complex Variable Theory and Differential Equations
ME 5650	Advanced Mechanics of Materials
ME 5654	Elasticity and Plasticity
ME 5655	Dynamics and Mechanical Vibration
ME 5657	Finite Element Method 1
ME 5658	Continuum Mechanics
ME 5659	Control Systems Engineering
ME 5665	Musculoskeletal Biomechanics
ME 7238	Finite Element Method 2

CONCENTRATION IN BIOMEDICAL DEVICES AND BIOIMAGING

Code	Title	Hours
Required Coursework		
A grade of C or higher is required:		
BIOE 5800	Systems, Signals, and Controls for Bioengineers	4
Complete two of the following:		8
BIOE 5235	Biomedical Imaging	
or BIOE 5648	Biomedical Optics	
BIOE 5250	Regulatory and Quality Aspects of Medical Device Design	
BIOE 5810	Design of Biomedical Instrumentation	
Complete one of the following options:		16
Coursework Option		
Complete 16 semester hours from the course list. Any course on the required course list not used toward the core requirement may also be taken.		
Project Option		
BIOE 7945	Master's Project	
Complete 12 semester hours from the course list. Any course on the required course list not used toward the core requirement may also be taken.		
Thesis Option		
BIOE 7945	Master's Project	
BIOE 7990	Thesis	
Complete 8 semester hours from the course list. Any course on the required course list not used toward the core requirement may also be taken.		
In addition to completing the thesis course, students must successfully complete the thesis submission process, including securing committee and Graduate School of Engineering signatures and submission of an electronic copy of their MS thesis to ProQuest.		

Course List

BIOE 5115	Dynamical Systems in Biological Engineering
BIOE 5250	Regulatory and Quality Aspects of Medical Device Design
BIOE 5510	Bioengineering Products/Technology Commercialization
BIOE 5520	Bioengineering Design for Robotic Rehabilitation
BIOE 5648	Biomedical Optics
or BIOE 5235	Biomedical Imaging
BIOE 5770	Machine Learning Methods in Biology and Health
BIOE 5810	Design of Biomedical Instrumentation
BIOE 5820	Biomaterials
or CHME 5631	Biomaterials Principles and Applications
BIOE 5850	Design of Implants

CHME 5632	Advanced Topics in Biomaterials
EECE 5606	Micro- and Nanofabrication
EECE 7200	Linear Systems Analysis
EECE 7203	Complex Variable Theory and Differential Equations
EECE 7204	Applied Probability and Stochastic Processes
ME 5657	Finite Element Method 1
NNMD 5370	Nanomedicine Research Techniques

CONCENTRATION IN MOLECULAR, CELL, AND TISSUE ENGINEERING

Code	Title	Hours
Required Coursework		
A grade of C or higher is required:		
BIOE 5410	Molecular Bioengineering	4
or BIOE 5411	Applied Molecular Bioengineering	
BIOE 5420	Cellular Engineering	4
Complete one of the following options:		19-20
<i>Coursework Option</i>		
Complete 19–20 semester hours from the course list. Any course on the required course list not used toward the core requirement may also be taken.		
<i>Project Option</i>		
BIOE 7945	Master's Project	
Complete 15–16 semester hours from the course list. Any course on the required course list not used toward the core requirement may also be taken.		
<i>Thesis Option</i>		
BIOE 7945	Master's Project	
BIOE 7990	Thesis	
Complete 11–12 semester hours from the course list. Any course on the required course list not used toward the core requirement may also be taken.		
In addition to completing the thesis course, students must successfully complete the thesis submission process, including securing committee and Graduate School of Engineering signatures and submission of an electronic copy of their MS thesis to ProQuest.		
Course List		
BIOE 5115	Dynamical Systems in Biological Engineering	
BIOE 5250	Regulatory and Quality Aspects of Medical Device Design	
BIOE 5411	Applied Molecular Bioengineering	
BIOE 5430	Principles and Applications of Tissue Engineering	
BIOE 5440	The Cell as a Machine	
BIOE 5450	Stem Cell Engineering	
BIOE 5510	Bioengineering Products/Technology Commercialization	
BIOE 5650	Multiscale Biomechanics	
BIOE 5660	Integrative Mechanobiology	
BIOE 5710	Experimental Systems and Synthetic Bioengineering	
BIOE 5711	Advanced Experimental Systems and Synthetic Bioengineering	
BIOE 5720	Physical Bioengineering	
BIOE 5770	Machine Learning Methods in Biology and Health	
BIOE 5820	Biomaterials	
or CHME 5631	Biomaterials Principles and Applications	
BIOL 5543	Stem Cells and Regeneration	
BIOL 6301	Molecular Cell Biology	
CHME 5160	Drug Delivery: Engineering Analysis	
CHME 5515	Process Safety Engineering for Biotechnology and Pharmaceutical Industries	
CHME 5632	Advanced Topics in Biomaterials	
NNMD 5370	Nanomedicine Research Techniques	
NNMD 5470	Nano/Biomedical Commercialization: Concept to Market	

CONCENTRATION IN SYSTEMS, SYNTHETIC, AND COMPUTATIONAL BIOENGINEERING

Code	Title	Hours
Required Coursework		
A grade of C or higher is required.		
Complete three of the following:		12
BIOE 5115	Dynamical Systems in Biological Engineering	
BIOE 5710	Experimental Systems and Synthetic Bioengineering	
BIOE 5720	Physical Bioengineering	
BIOE 5750	Modeling and Inference in Bioengineering	
Complete one of the following options:		15-16
<i>Coursework Option</i>		
Complete 15-16 semester hours from the course list. Any course on the required course list not used toward the core requirement may also be taken.		
<i>Project Option</i>		
BIOE 7945	Master's Project	
Complete 11-12 semester hours from the course list. Any course on the required course list not used toward the core requirement may also be taken.		
<i>Thesis Option</i>		
BIOE 7945	Master's Project	
BIOE 7990	Thesis	
Complete 7-8 semester hours from the course list. Any course on the required course list not used toward the core requirement may also be taken.		
In addition to completing the thesis course, students must successfully complete the thesis submission process, including securing committee and Graduate School of Engineering signatures and submission of an electronic copy of their MS thesis to ProQuest.		
Course List		
BINF 6400	Genomics in Bioinformatics	
BIOE 5115	Dynamical Systems in Biological Engineering	
BIOE 5440	The Cell as a Machine	
BIOE 5510	Bioengineering Products/Technology Commercialization	
BIOE 5640	Computational Biomechanics	
BIOE 5711	Advanced Experimental Systems and Synthetic Bioengineering	
BIOE 5750	Modeling and Inference in Bioengineering	
BIOE 5760	Method and Logic in Systems Biology and Bioengineering	
BIOE 5770	Machine Learning Methods in Biology and Health	
BIOE 5860	Engineering Approaches to Precision Medicine I	
BIOE 5870	Engineering Approaches to Precision Medicine II	
BIOE 5880	Computational Methods in Systems Bioengineering	
BIOL 6299	Molecular Cell Biology for Biotechnology	
CHEM 5638	Molecular Modeling	
CHME 5630	Biochemical Engineering	
DS 5110	Essentials of Data Science	
DS 5220	Supervised Machine Learning and Learning Theory	
DS 5230	Unsupervised Machine Learning and Data Mining	
HINF 5101	Introduction to Health Informatics and Health Information Systems	
PHTH 5202	Introduction to Epidemiology	
PHYS 5116	Network Science 1	

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