

# Biological Engineering

## Course 20

Biological Engineering [BE] was founded in 1998 as a new MIT departmental academic unit, with the mission of defining and establishing a new discipline fusing molecular life sciences with engineering. The goal of this biological engineering discipline is to advance fundamental understanding of how biological systems operate and to develop effective biology-based technologies for applications across a wide spectrum of societal needs including breakthroughs in diagnosis, treatment, and prevention of disease; in design of novel materials, devices, and processes; and in enhancing environmental health. The innovative educational programs created by BE reflect this emphasis on integrating molecular and cellular biosciences with a quantitative, systems-oriented engineering analysis and synthesis approach, offering opportunities at the undergraduate level for the SB in Biological Engineering; and at the graduate level for the PhD in either Applied Biosciences or Bioengineering. BE also partners with the departments of Biology and Electrical Engineering & Computer Science to jointly offer a PhD in Computational & Systems Biology and in Microbiology. Research opportunities for BE undergraduate students, graduate students, and postdoctoral associates abound across an exciting landscape of interdisciplinary laboratories, centers, and initiatives, including the Biotechnology Process Engineering Center, the Center for Biomedical Engineering, the Center for Environmental Health Sciences, the Division of Comparative Medicine, and the Registry of Standard Biological Parts. Graduate students in the BE PhD programs can participate in the NIGMS Biotechnology Training Program, the NIGMS Chemistry-Biology Interface Training Program, the NIEHS Toxicology Training Program, and the NIBIB Biomechanics Training Program.

### **About Biological Engineering**

Advances in basic biology at the molecular and cellular levels during recent decades have dramatically increased the foundational information available on mechanistic

underpinnings of biological systems. Indeed, the genomics revolution has accelerated the pace at which reductionist data is being generated. It is widely agreed that a crucial challenge for the coming decades is how to integrate information from the genomic level to higher levels of system organization, for both fundamental scientific understanding and development of innovative biotechnologies. Engineering disciplines are predicated on the complementary principles of analysis and synthesis, combining to elucidate quantitative "design principles" for the dependence of system behavior on component properties. The "measurement, modeling, and manipulation" approach that has characterized engineering disciplines based on the sciences of physics and chemistry is now finding the molecular and cellular life sciences accessible and amenable as well. Thus, a new discipline of biological engineering is emerging, directed toward analysis of biological systems in terms of key component properties and consequently toward synthesis of technologies that can beneficially modify and control such systems for societal benefit across many, diverse application areas including human and environmental health.

### **Areas of Research Offered**

Engineers and applied scientists aim to solve complicated problems arising from societal needs and concerns; that's our great strength. Biological engineers address these problems by fusing quantitative, often systems-oriented, integrative analysis and design approaches together with cutting-edge bioscience. Until recently, reliable methods did not exist for accessing biological systems broadly at their mechanistic (molecular and cellular) levels, for purposes of not only understanding them but of altering or designing them to carry out desired useful functions. Today, biological engineers are at the forefront of developing these powerful, innovative methods and employing them in exciting new ways for societal benefit over a wide range of vital applications in human and environmental health and various diverse industries. The project areas to be

found in our Biological Engineering research program, across our world-class faculty and center laboratories, are ideal for learning how to effectively address important problems combining engineering principles and perspective with the knowledge and tools of modern molecular life sciences.

MIT's Biological Engineering faculty direct leading-edge research programs across the wide range of this exciting new field:

Biological Transport Phenomena  
Biological Imaging  
Biomaterials  
Biomolecular Engineering  
Biophysics  
Cell and Tissue Engineering  
Computational Biology  
Discovery and Delivery of Molecular Therapeutics  
Energy  
Genetic Toxicology  
Infectious Disease and Immunology  
Macromolecular Biochemistry & Biophysics  
Metabolism of Drugs and Toxins  
Microbial Pathogenesis  
Microbial Systems  
Molecular, Chemical and Environmental Carcinogenesis  
Molecular, Cell and Tissue Biomechanics  
Molecular Epidemiology and Dosimetry  
Molecular Pharmacology  
Nanoscale Engineering of Biological Systems  
Neurobiological Systems  
Synthetic Biology  
Systems Biology

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More information is also available on the web at  
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The MIT Bulletin, Courses and Degree Programs Issue, contains further information on the Institute, including all graduate and undergraduate courses and programs. For details on ordering the course catalogue, please visit the MIT Press Bookstore website at  
<http://mitpress.mit.edu/bookstore/bulletin.html>.

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