

# Biological Engineering Division

## Overview

The Biological Engineering Division (BE) continues to grow in terms of world-class faculty and students, innovative educational programs, and forefront research programs, thus pursuing its mission of fostering MIT education and research that fuse engineering with molecular life sciences. Our central objective is to define and lead the new biology-based engineering discipline we term biological engineering. The foundational premise of BE is that the science of biology will be as important to technology and society in this century as physics and chemistry have been in the previous one. Therefore, to translate the revolution in modern biology into a corresponding revolution in biology-based technologies, a new biology-based discipline of bioengineering must be established. We are endeavoring to educate engineers and scientists who can apply their measurement and modeling perspectives to understanding how biological systems operate, especially when perturbed by genetic, chemical, mechanical, or materials interventions or subjected to pathogens or toxins; and also apply their design perspective to creating innovative biology-based technologies in medical diagnostic, therapeutic, and device industries, as well as in non-health-related industrial sectors such as agriculture, environment, materials, manufacturing, and defense. Our programs are producing a new generation of engineers and scientists capable of solving problems using modern biotechnology, emphasizing an ability to measure, model, and rationally manipulate biological systems.

An extraordinary — yea, historic! — note from academic year 2006 is that Biological Engineering has officially become Course 20 at MIT.

## Faculty and Staff

The current BE faculty members (with other MIT academic unit affiliations noted in parentheses) are:

- Eric Alm (Civil and Environmental Engineering)
- Angela Belcher (Materials Science and Engineering)
- Chris Burge (Biology)
- Arup Chakraborty (Chemical Engineering, Chemistry)
- Peter Dedon
- Edward DeLong (Civil and Environmental Engineering)
- Forbes Dewey (Mechanical Engineering)
- Drew Endy
- Bevin Engelward
- John Essigmann (Chemistry)
- James Fox
- Ernest Fraenkel
- Linda Griffith (Mechanical Engineering)

Alan Grodzinsky (Electrical Engineering and Computer Science, Mechanical Engineering)

Kimberly Hamad-Schifferli (Mechanical Engineering)

Jongyoon Han (Electrical Engineering and Computer Science)

Darrell Irvine (Materials Science and Engineering)

Roger Kamm (Mechanical Engineering)

Alexander Klibanov (Chemistry)

Mathew Lang (Mechanical Engineering)

Robert Langer (Chemical Engineering)

Douglas Lauffenburger (Biology, Chemical Engineering)

Harvey Lodish (Biology)

Scott Manalis (Mechanical Engineering)

Paul Matsudaira (Biology)

Leona Samson (Biology)

Ram Sasisekharan

David Schauer

James Sherley

Peter So (Mechanical Engineering)

Peter Sorger (Biology)

Subra Suresh (Materials Science and Engineering)

Steven Tannenbaum (Chemistry)

William Thilly

Bruce Tidor (Electrical Engineering and Computer Science)

Forest White

Dane Wittrup (Chemical Engineering)

Gerald Wogan

Michael Yaffe (Biology)

Ioannis Yannas (Mechanical Engineering, Materials Science and Engineering).

Douglas Lauffenburger continues as director of BE, and Peter Dedon assists him ably as associate director. Alan Grodzinsky is chair of the BE Graduate Program, and Linda Griffith is chair of the BE Undergraduate Program. Rolanda Dudley-Cowans is our administrative officer, and Dalia Gabour is our academic administrator.

## Research

During fiscal year 2006, the sponsored research volume officially administered within BE was approximately \$10.5 million. Note that this figure includes only those sponsored

projects formally assigned to the Division, which represent only a minor portion of the research funding garnered by BE faculty. Most BE faculty members additionally operate substantial sponsored research projects supervised administratively within other departments and centers. These include the Biotechnology Process Engineering Center, the Center for Biomedical Engineering, the Center for Environmental Health Sciences, the Computational and Systems Biology Initiative (CSBi), the Division of Comparative Medicine, the Registry of Standard Biological Parts, and the Whitehead–MIT BioImaging Center, all of which are directed by BE faculty members (respectively, Linda Griffith, Alan Grodzinsky, Leona Samson and Peter Dedon, Paul Matsudaira and Bruce Tidor, James Fox, Drew Endy, and Paul Matsudaira and Peter So). The total sponsored research volume undertaken by BE faculty during the past year was well over \$25 million. Major research areas within BE include biological and physiological transport phenomena; biological imaging and functional measurement; biomaterials; biomolecular engineering and cell and tissue engineering; computational biology and bioinformatics; discovery, design, and delivery of molecular therapeutics; genetic toxicology; macromolecular biochemistry and biophysics; metabolism of drugs and toxins; microbial pathogenesis; carcinogenesis; biomechanics; molecular epidemiology; molecular pharmacology; and genomics, proteomics, and glycomics. A special highlight of this past year, as usual, was the 5th Annual BE Division Retreat. More than 170 faculty, graduate students, and staff gathered at a conference center in Hyannis, MA, for a tremendously stimulating and enjoyable two days of research, education, and ethics discussions and social interactions away from campus. We are grateful to Mrs. Janet Michaels for her generous support of this important event.

### **Undergraduate Education**

We are excited about the approval of our landmark new SB major program in Biological Engineering, which got underway during academic year 2006 with 29 enthusiastic sophomores. From our perspective, there is no similar undergraduate degree program anywhere in the country. It is centered on genetics, biochemistry, molecular biology, and cell biology as its science foundation and fuses this science with quantitative, integrative-systems design-oriented engineering principles and approaches (for example, thermodynamics, kinetics, mechanics, transport, fields, instrumentation, programming, and computation), including two hands-on laboratory subjects. We expect that our graduates will find attractive career opportunities across a spectrum of industrial, academic, and professional areas.

We also continue to administer two SB minor programs: Biomedical Engineering (BME) and Toxicology and Environmental Health (Tox/EH). In addition, we administer the five-year MEng Program in Biomedical Engineering, bioengineering track. In June 2006, we had 72 graduates with the BME minor, 3 graduates with the Tox/EH minor, and 4 graduates with the BME/BE MEng. Unusually for School of Engineering programs, the aggregate population of these graduates represents women in the majority.

### **Graduate Education**

BE continues to administer a PhD in biological engineering, with formal tracks in bioengineering and applied biosciences. Our current enrollment is 105: 76 in the bioengineering track and 29 in the applied bioscience track. Similarly to the BE Division

undergraduate programs, our graduate student population represents women and men in roughly equal numbers. The Division graduated 15 PhD students this year, 10 in the bioengineering track and 5 in the applied biociences track.

BE is also the administrative home for the Computational and Systems Biology PhD program, formally partnered with the Departments of Biology and Electrical Engineering and Computer Science. Bruce Tidor is director of the CSBi PhD program, and Darlene Ray is its academic officer. This program is underway now, with four students having completed their 2nd year of study and eight having completed their 1st year of study.

We are deeply appreciative of wonderfully generous gifts for graduate student fellowships, most notably from Andrew and Edna Viterbi for Viterbi graduate fellowships in systems biology, Gordon and Adele Binder for Binder graduate fellowships in biotechnology, Susan Whitehead for Whitehead graduate fellowships in biological engineering, Noubar Afeyan for Afeyan graduate fellowships in biological engineering, and Momenta Pharmaceuticals for presidential graduate fellowships. Additionally, we have received financial support for graduate fellowships from the Medtronic Foundation, the DuPont/MIT Alliance, the Merck/MIT Partnership, and the Whitaker Foundation.

Additionally, BE is grateful for other generous gifts toward important aspects of our ongoing program growth. These include a gift from Jerrold and Louse Grochow for support of women faculty and students, and gifts from Cliff Reid and Naimish Patel to help catalyze key Division initiatives.

**Douglas A. Lauffenburger**  
**Director**  
**Whitaker Professor of Bioengineering**

*More information about the Biological Engineering Division can be found at <http://web.mit.edu/be/>.*