

Division of Biological Engineering

Overview

The Biological Engineering Division (BE) continues to grow in terms of world-class faculty and students, innovative educational programs, and forefront research programs in 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 that we term biological engineering. The foundational premise of BE is that the science of biology will be as important to technology and society in the next 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 (a) 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 (b) 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. This should lead to a new generation capable of solving problems using modern biotechnology, emphasizing an ability to measure, model, and rationally manipulate biological systems.

Faculty and Staff

The current BE faculty members (with other MIT academic unit affiliations noted in parentheses) are Angela Belcher (Materials Science and Engineering), Peter Dedon, William Deen (Chemical Engineering), Edward DeLong (Civil and Environmental Engineering), Forbes Dewey (Mechanical Engineering), Drew Endy, Bevin Engelward, John Essigmann (Chemistry), James Fox, 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), Ian Hunter (Mechanical Engineering), 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), and 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.

Among major awards received by BE faculty members during academic year 2005 are the following: Angela Belcher, MacArthur Foundation Fellow; Ed DeLong, American Academy of Arts and Sciences, Gordon Moore Foundation Chair; John Essigmann, Princess Chulabhorn Gold Medal; Jim Fox, Institute of Medicine; Kim Hamad-Schifferli, ONR Young Investigator Award; Darrell Irvine, Beckman Young Investigator Award, NSF CAREER Award; Bob Langer, Institute Professor, Albany Medical Center Prize; Peter So, Francis Perkins Award; Subra Suresh, American Academy of Arts and Sciences; and Jerry Wogan, Charles S. Mott Prize for Cancer Research.

Research

During fiscal year 2005, the sponsored research volume officially administered within BE was approximately \$8M. 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 Division 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 (BPEC), the Center for Biomedical Engineering (CBE), the Center for Environmental Health Sciences (CEHS), the Computational and Systems Biology Initiative (CSBi), the Division of Comparative Medicine (DCM), the Registry of Standard Biological Parts (RSBP), and the Whitehead-MIT BioImaging Center (BIC), all of which are directed by BE faculty members (respectively, Linda Griffith; Alan Grodzinsky; Leona Samson and Peter Dedon; Paul Matusdaira 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 \$20M. 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 4th Annual BE Division Retreat. More than 150 faculty, graduate students, and staff gathered at a conference center in Portland, ME, 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 new landmark SB major degree program in Biological Engineering, which gets underway in academic year 2006. In our view, 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 (e.g., thermodynamics, kinetics, mechanics, transport, fields,

instrumentation, programming, and computation), including two hands-on laboratory subjects. We expect that our graduates will find tremendous 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)—along with the five-year MEng Program in Biomedical Engineering (bioengineering track). In June 2005, we had 65 graduates with the BME minor, 6 graduates with the Tox/EH Minor, and 8 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 offers the PhD in biological engineering with formal tracks in bioengineering and in applied bioscience and diverse fields of specialization (such as biomaterials, biomechanics, computational biology, pharmacology, toxicology, etc.). Our current total enrollment in these programs is 110; as with the BE undergraduate programs, our graduate student population represents women and men in roughly equal numbers. During this past year, we graduated 14 PhD students and 4 SM students as we continue to grow toward a steady state expected to yield approximately 25 PhD graduates per year.

BE is also the administrative home of the Computational and Systems Biology (CSBi) 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. In its first year of operation, academic year 2005, this program began with four first-year students; eight are enrolling for the upcoming academic year.

We are deeply appreciative of wonderfully generous gifts for graduate student fellowships, most notably from Andrew and Edna Viterbi for Viterbi graduate fellowships in computational biology and bioinformatics, Gordon and Adele Binder for Binder graduate fellowships in molecular and cell bioengineering, Susan Whitehead for Whitehead graduate fellowships in biological engineering, and Noubar Afeyan for Afeyan graduate fellowships in biological engineering. 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 a gift from Cliff Reid to help catalyze key division initiatives.

Douglas A. Lauffenburger
Director
Whitaker Professor of Bioengineering

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