

Department of Biological Engineering

The Department of Biological Engineering (BE) continues to grow and gain prominence thanks to world-class faculty and students, innovative educational programs, and leading-edge research programs that advance our mission of fostering education and research by fusing engineering with molecular life sciences. Our central objective is to define and lead a new biology-based engineering discipline that we call 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 endeavor to educate engineers and scientists who can apply measurement and modeling perspectives to understanding how biological systems operate, especially when perturbed by genetic, chemical, mechanical, or materials interventions or when subjected to pathogens or toxins; and 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 energy, environment, materials, manufacturing, and national defense. Our programs are producing a generation of engineers and scientists capable of solving problems by 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 as follows: Eric Alm (Civil and Environmental Engineering [CEE]), Mark Bathe, Angela Belcher (Materials Science and Engineering [MSE]), Chris Burge (Biology), Arup Chakraborty (Chemical Engineering [ChemEng], Chemistry), Peter Dedon, Edward DeLong (CEE), Forbes Dewey (Mechanical Engineering [MechEng]), Bevin Engelward, John Essigmann (Chemistry), James Fox, Ernest Fraenkel, Linda Griffith (MechEng), Alan Grodzinsky (Electrical Engineering and Computer Science [EECS], MechEng), Kimberly Hamad-Schifferli (MechEng), Jongyoon Han (EECS), Darrell Irvine (MSE), Alan Jasanoff, Roger Kamm (MechEng), Alexander Klibanov (Chemistry), Robert Langer (ChemEng, Health Sciences and Technology [HST]), Douglas Lauffenburger (Biology, ChemEng), Harvey Lodish (Biology), Scott Manalis (MechEng), Jacquin Niles, Katharina Ribbeck, Leona Samson (Biology), Ram Sasisekharan (HST), Peter So (MechEng), Steven Tannenbaum (Chemistry), William Thilly, Bruce Tidor (EECS), Ron Weiss (EECS), Forest White, Dane Wittrup (ChemEng), Michael Yaffe (Biology), and Ioannis Yannas (MechEng, MSE).

Douglas Lauffenburger continues as head of BE and Bruce Tidor assists him as associate head. Dane Wittrup is chair of the BE graduate program and Scott Manalis is chair of the BE undergraduate program. Rolanda Dudley-Cowans is our administrative officer, and Dalia Fares is our academic administrator.

Research

During fiscal year 2010, the total sponsored research volume supervised by BE faculty members was more than \$51 million. This figure includes sponsored projects formally administered by the department (which equal close to \$13 million) as well as projects directed by BE faculty members supervised administratively within other departments and centers, including the Center for Biomedical Engineering (Alan Grodzinsky, director), Center for Environmental Health Sciences (Leona Samson, director; Peter Dedon, deputy director), Center for Gynepathology Research (Linda Griffith, director), Computational and Systems Biology Initiative (Douglas Lauffenburger, director; Bruce Tidor, co-director), Division of Comparative Medicine (James Fox, director), and Koch Institute for Integrative Cancer Research. 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 highlight of this past year was the 9th annual BE retreat. More than 170 faculty, graduate students, and staff gathered at a conference center in Newport, RI, for a tremendously stimulating and enjoyable two days of research, education, and ethics discussions and social interactions away from campus.

Undergraduate Education

We are excited about the continued growth of our SB degree program in biological engineering. In June 2008, 23 pioneering students graduated from BE, followed by 47 in June 2009 and 39 in June 2010. We now have approximately 60 rising seniors in our program, 50 rising juniors, and 70 rising sophomores for the 2010–2011 academic year. From our perspective, there is no similar undergraduate degree program elsewhere nationally that is centered on genetics, biochemistry, molecular biology, and cell biology as its science foundation and that 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. Judging from our initial cohort of graduates, we expect that our uniquely educated Course 20 students will continue to find attractive career opportunities across a spectrum of industrial, academic, and professional areas.

We also administer two SB minor programs in biomedical engineering (BME) and in toxicology and environmental health. In addition, we administer a five-year master of engineering (MEng) program in biomedical engineering with a bioengineering track. In June 2010, 11 students graduated with a minor in BME and one MEng graduate in BME/BE. The majority of these graduates were women, which is unusual for programs in the School of Engineering.

Graduate Education

BE continues to administer a PhD in biological engineering with two tracks—one in bioengineering and one in applied biosciences—bringing our current enrollment to 114, with 60 in the bioengineering track, 33 in the applied biosciences track, and 21 incoming students who have not yet designated their track. Similar to the BE undergraduate programs, our graduate student population represents women and men in roughly equal numbers. The department graduated 16 PhD students in June 2010, with 13 in the bioengineering track and three in the applied biosciences track.

We are deeply appreciative of wonderfully generous gifts for graduate student fellowships, most notably from Andrew and Edna Viterbi for the Viterbi graduate fellowships in systems biology, Gordon and Adele Binder for the Binder graduate fellowships in biotechnology, Susan Whitehead for the Whitehead graduate fellowships in biological engineering, Noubar Afeyan for the Afeyan graduate fellowships in biological engineering, Cynthia Cargill for the Cargill graduate fellowships in applied bioscience, and Momenta Pharmaceuticals for the presidential graduate fellowships. Additionally we have received financial support for graduate fellowships from the Medtronic Foundation and the MIT Energy Initiative.

BE is grateful for other generous gifts toward important aspects of our ongoing program growth, including gifts from Cliff Reid and Stanley Charm for important departmental initiatives.

Douglas A. Lauffenburger
Department Head
Ford Professor

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