

Department of Biological Engineering

The Department of Biological Engineering (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 fusing engineering with molecular life sciences. Our central objective is to define and lead the new biology-based engineering discipline, which 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: (1) apply their 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 (2) 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 new generation of engineers and scientists 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 as follows: Eric Alm (Civil and Environmental Engineering), Mark Bathe, 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), 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), Alan Jasanoff, Roger Kamm (Mechanical Engineering), Alexander Klibanov (Chemistry), Matthew Lang (Mechanical Engineering), Robert Langer (Chemical Engineering), Douglas Lauffenburger (Biology, Chemical Engineering), Harvey Lodish (Biology), Scott Manalis (Mechanical Engineering), Jacquin Niles, Leona Samson (Biology), Ram Sasisekharan, Peter So (Mechanical Engineering), Steven Tannenbaum (Chemistry), William Thilly, Bruce Tidor (Electrical Engineering and Computer Science); Forest White, Dane Wittrup (Chemical Engineering), Michael Yaffe (Biology), Jacquelyn Yanch, Ioannis Yannas (Mechanical Engineering, Materials Science and Engineering). We are exceedingly sorrowful to report the untimely, tragic death of David Schauer, who for many years had been a vital faculty colleague and leader in research, education, and service.

Douglas Lauffenburger continues as head of BE and Peter Dedon assists him as associate head. Peter Dedon is also 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 2008, the sponsored research volume officially administered within BE was approximately \$11.6 million—noting that this figure represents only those sponsored projects formally assigned to the department, which represent only a minor portion of the research funding garnered by BE faculty; most BE faculty members also operate substantial sponsored research projects supervised administratively within other departments and centers, including the Biotechnology Process Engineering Center (Linda Griffith, director), Center for Biomedical Engineering (Alan Grodzinsky, director), Center for Environmental Health Sciences (Leona Samson, director; Peter Dedon, deputy director), Computational and Systems Biology Initiative (CSBi; Douglas Lauffenburger, director; Bruce Tidor, codirector), Division of Comparative Medicine (James Fox, director), and the Whitehead–MIT BioImaging Center (Peter So, director), all of which are directed by BE faculty members. The total sponsored research volume undertaken by BE faculty during the past year was well over \$26 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 8th Annual BE retreat. More than 150 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 rapid growth of our landmark new SB major degree program in BE, which is under way with 23 pioneering students having graduated in June 2008 and 47 in June 2009. We now have approximately 45 rising seniors, and 65 rising juniors in our program for the forthcoming 2009–2010 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 continue to administer two SB minor programs, in biomedical engineering (BME) and in toxicology and environmental health (Tox/EH). In addition, we administer a five-year MEng program in a biomedical engineering, bioengineering track. In June 2009, we had 12 graduates with the BME minor, one graduate with the Tox/EH

Minor, and two graduates with the BME/BE MEng. Unusual 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 two tracks—one in bioengineering and one in applied biosciences—bringing our current enrollment to 110, with 60 in the bioengineering track, 31 in the applied biosciences track, and 19 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 20 PhD students in June 2008, with 14 in the bioengineering track and 6 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 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, Cynthia Cargill for Cargill graduate fellowships in applied bioscience, and Momenta Pharmaceuticals for 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 gift 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/>.