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 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.

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); Angela Belcher (Materials Science and Engineering); Chris Burge (Biology); Arup Chakraborty (Chemical Engineering, Chemistry); Peter Dedon and Edward DeLong (Civil and Environmental Engineering); Forbes Dewey (Mechanical Engineering); Bevin Engelward and John Essigmann (Chemistry); James Fox, Ernest Fraenkel, and 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); Matthew Lang (Mechanical Engineering); Robert Langer (Chemical Engineering); Douglas Lauffenburger (Biology, Chemical Engineering); Harvey Lodish (Biology); Scott Manalis (Mechanical Engineering); Leona Samson (Biology); Ram Sasisekharan, David Schauer, and Peter So (Mechanical Engineering); Subra Suresh (Materials Science and Engineering); Steven Tannenbaum (Chemistry); William Thilly and Bruce Tidor (Electrical Engineering and Computer Science); Forest White and Dane Wittrup (Chemical Engineering); Michael Yaffe (Biology); and Ioannis Yannas (Mechanical Engineering, Materials Science and Engineering). Douglas Lauffenburger continues as head of BE and Peter Dedon assists him as associate head. 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 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), Registry of Standard Biological Parts (Andrew Endy, 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 7th Annual BE retreat. More than 170 faculty, graduate students, and staff gathered at a conference center in Durham, New Hampshire, 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 establishment of our landmark new SB major degree program in BE, which is under way with 23 pioneering students having graduated in June 2008. We now have approximately 50 seniors, and 60 rising juniors in our program for the forthcoming 2008–2009 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 2008, we had 26 graduates with the BME minor, two graduates with the Tox/EH Minor, and five 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 93, with 67 in the bioengineering track and 26 in the applied biosciences track. Similar to the BE undergraduate programs, our graduate student population represents women and men in roughly equal numbers. The Department graduated 25 PhD students in June 2008, with 20 in the bioengineering track and five in the applied biosciences track.

BE is also the administrative home for the CSBi PhD program, formally partnered with the departments of Biology and Electrical Engineering and Computer Science. Chris Burge is director of the CSBi PhD program, and Darlene Ray is its academic officer. This program is under way with three students having completed their fourth year, seven having completed their third year, seven having completed their second year, and seven having completed their first 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.

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

Douglas A. Lauffenburger
Department Head
Whitaker Professor of Biological Engineering, Biology, and Chemical Engineering

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