

## 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 (BE). 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. Our central theme is creating biological technologies, from discovery to design; or, more colloquially, designing the biology, not just the box.

In academic year 2021 (AY2021), the Department of Biological Engineering maintains its position as the fourth-largest department in the School of Engineering and the fifth largest in the Institute. Our department is ranked first for biological and biomedical engineering programs, according to *U.S. News & World Report*. We continue to grow, perhaps owing to the central role that biological engineering is playing in solving critical global problems around health and energy.

### Faculty and Staff

Our 38 core and associated faculty have over 900,000 citations and continue to publish in top scientific journals and lead their fields of study. 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 (Mechanical Engineering), Angela Belcher (Materials Science & Engineering), Michael Birnbaum, Paul Blainey, Edward Boyden (Brain and Cognitive Sciences, Media Lab of Arts and Sciences), Laurie Boyer (Biology), Bryan Bryson, James Collins (Institute for Medical Engineering and Science), Peter Dedon, Bevin Engelward, John Essigmann (Chemistry), James Fox, Ernest Fraenkel, David Gifford (Electrical Engineering & Computer Science), Linda Griffith (Mechanical Engineering), Alan Grodzinsky (Electrical Engineering & Computer Science, Mechanical Engineering), Jongyoon Han (Electrical Engineering & Computer Science), Anders Hansen, Darrell Irvine (Materials Science & Engineering), Alan Jasanoff (Brain and Cognitive Sciences), Roger Kamm (Mechanical Engineering), Amy Keating (Biology), Alexander Klibanov (Chemistry), Angela Koehler, Robert Langer (Chemical Engineering), Douglas Lauffenburger (Biology, Chemical Engineering), Harvey Lodish (Biology), Timothy K. Lu (Electrical Engineering & Computer Science), Scott Manalis (Mechanical Engineering), Jacquin Niles, Katharina Ribbeck, Ram Sasisekharan, Peter So (Mechanical Engineering), Steven Tannanbaum, William Thilly, Bruce Tidor (Electrical Engineering & Computer Science), Krystyn Van Vliet (Materials Science and Engineering), Christopher Voigt, Ron Weiss (Electrical Engineering & Computer Science), Forest White, Dane Wittrup (Chemical Engineering), Michael Yaffe (Biology), and Feng Zhang (Brain & Cognitive Sciences).

Kelly Metcalf-Pate joined the department March 1, 2021, as associate professor with tenure. She is also the director of the Division of Comparative Medicine, taking over for

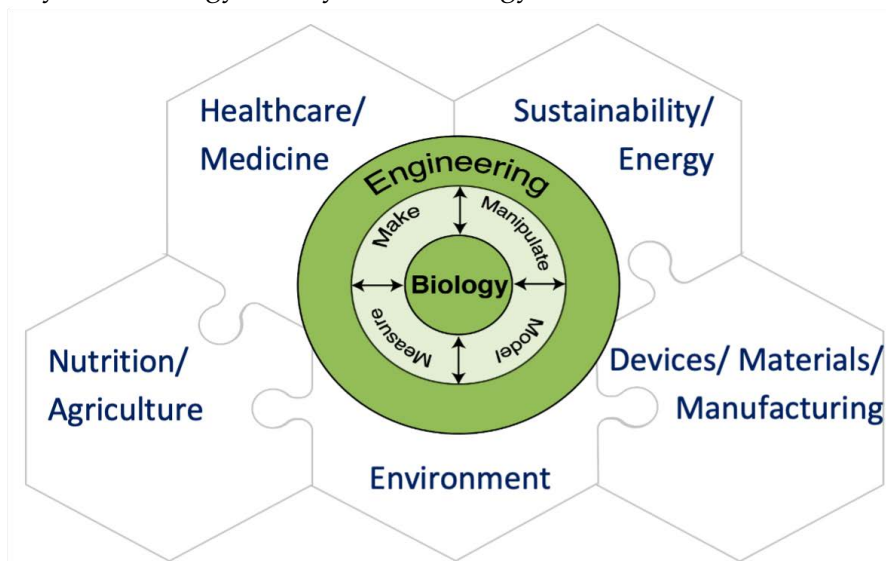
James Fox. Katharina Ribbeck was promoted to full professor, and Michael Birnbaum was promoted to associate professor without tenure. Angela Belcher continued as head of BE, with Scott Manalis assisting her as associate head. Paul Blainey and Katharina Ribbeck are co-chairs of the BE graduate program, and Michael Birnbaum and Forest White are co-chairs of the BE undergraduate program. Rolanda Dudley-Cowans is our administrative officer, and Dalia Fares is our academic administrator.

Despite the COVID-19 pandemic during AY2021, our faculty continued to excel and won many awards. To highlight a few, Doug Lauffenburger and Linda Griffith were awarded the Bernard M. Gordon Prize for Engineering Education from the National Academy of Engineering in 2021. Linda Griffith and Leona Samson were elected to the American Academy of Arts and Sciences. James Collins was awarded the Dickson Prize in Medicine. Michael Birnbaum and Anders Hansen were awarded the National Institutes of Health Innovator's Award. Michael Birnbaum was awarded the Michelson Prize.

## Research

During fiscal year 2021, the total amount of sponsored research volume supervised by BE faculty members was approximately \$61.9 million. This figure includes sponsored projects formally administered by the department (more than \$26 million) as well as projects directed by BE faculty members supervised administratively within other departments and centers, including but not limited to the Center for Biomedical Engineering, Center for Environmental Health Sciences, Computational and Systems Biology Initiative, Division of Comparative Medicine, Institute for Medical Engineering and Science, and the Koch Institute.

Major research areas within biological engineering include biological imaging; biomaterials; biomolecular engineering; cell and tissue engineering; computational biology and bioinformatics; discovery, design, and delivery of molecular therapeutics; molecular and cellular biophysics; infectious disease and immunology; microbial ecosystems; neurobiology and neuroengineering; biomechanics; molecular epidemiology; molecular pharmacology and toxicology; genomics, proteomics, and glycomics; systems biology; and synthetic biology.



## Undergraduate Education

We are excited about the continuing growth of our pioneering Course 20 major program. We had 49 graduating seniors in 2021 and have approximately 48 seniors, 57 juniors, and 67 sophomores for the forthcoming AY2022. 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, 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 minor programs, one in biomedical engineering and the other in toxicology and environmental health. In addition, we administer a five-year MEng program in a biomedical engineering, bioengineering track. The current undergraduate numbers are in the range of 80% female and 20% male.

## Graduate Education

Our current enrollment is 139 graduate students, predominantly in the PhD program. The department graduated 13 PhD students and one MEng for AY2021. Our graduate student population represents women and men in roughly equal numbers. The department is proud of the leadership of our graduate students, both while at MIT and after they graduate and help to grow the field through innovation and impact. This impact is shown through the many institutional awards they have won, the leadership they show when they graduate, and the accolades they receive in their careers.

## Special Programs

During AY2021, the Department of Biological Engineering continued to launch and expand new initiatives. The Biomaker Space—a collaboration with the Department of Chemical Engineering—continued to provide resources and maker space to young biological and chemical engineers.

BE launched the BE Data and Coding Lab, which supported over 150 appointments with more than 40 clients, adding 150 computational teaching hours to the curriculum. Appointments came from undergraduate and graduate students and postdoctoral scientists who wanted to implement coding and large data analysis into their research workflow.

Like many departments at MIT and around the country, BE spent much of AY2021 thinking about belonging, inclusion, and diversity within the department. To support these efforts as a community, we launched a diversity, equity, and inclusion collaborative comprised of four working groups: Enhancing the Educational Experience, Outreach and Recruitment, Professional Development and Advising, and Inclusive Community. Each working group is comprised of faculty, staff, and students who work together to discuss, propose, and implement ideas within these four working areas in the department. We learned a lot about our community and made great efforts to bring the community closer during a very isolating year.

## Departmental COVID-19 Response

The COVID-19 pandemic played a significant role in the department's efforts throughout AY2021. We were forced to change the way we taught, did research, and collaborated.

In classrooms, instructors and teaching staff were able to put together “Nerd Kits” (20.309) and in-lab workshops (spring 2021) to support student learning despite regulations. Teaching staff worked closely across classes to ensure better student support. Advisors worked closely to support student mental health and classroom success. We increased our professional development support through weekly office hours and added check-ins to ensure that all students were able to get internships and jobs.

In the labs, many research programs pivoted to do more computational work or COVID-19 related work to help move the science forward. Our environmental health and safety officer and lab managers worked closely to help trainees get back into labs as soon as possible in a safe manner. COVID-19 also led to new and exciting collaborations in a variety of research areas.

Due to COVID-19, the annual BE Retreat was canceled and moved to March 2022. Our BE Departmental Seminar was moved online, and viewership reached all-time highs through increased accessibility. Attendance for our weekly graduate student seminars also increased, and online access allowed students' friends and family from abroad to attend their presentations.

## Resource Development

BE is grateful for generous gifts toward important aspects of our ongoing program growth, including major gifts from Emily and Malcolm Fairbairn '84, SM '85 (Lyme Disease Research), Northpond Ventures (BE Data Lab), John Begg (Gynepathology Research), Thomas and Alba Tull (Lyme Disease Research), Gordon Burrer '55 (Synthetic Biology Center), and John Little '78 (BE Data Lab).

As we head into fiscal year 2022, we are excited to continue our upward trajectory as a leader in innovation, education, and research. We are focused on continuing our cutting-edge research in health, climate, energy, and the environment, and we remain excited to continue innovating in the education space and in establishing new programming. We look forward to building on the momentum from 2020 as we move into the next academic year.



**Angela M. Belcher**  
**Department Head**  
**Ford Professor of Engineering**