

## Department of Biology

Academic year 2016 was an exciting and productive one for the [Department of Biology](#). The department is considered one of the best biological science departments in the world. Our superb faculty members are leaders in biological research and education. Highlights of the department's faculty, research, and educational programs are noted below.

### Faculty Count, Promotions, and Departures

During academic year 2016, the Department of Biology had 58 faculty members—44 full professors, eight associate professors, and six assistant professors. Research homes are distributed between Building 68, the Broad Institute, the Koch Institute for Integrative Cancer Research, the Picower Institute for Learning and Memory, and the Whitehead Institute.

In addition to 58 primary faculty members, there were seven faculty members with secondary appointments in Biology. These joint faculty members provide important connections to other departments, including Brain and Cognitive Sciences, Chemistry, Biological Engineering, and Civil and Environmental Engineering.

JoAnne Stubbe, whose home department is Chemistry but who held a joint appointment in Biology, retired effective June 30, 2015.

### Faculty Awards

Angelika Amon was the recipient of the American Association for Cancer Research Women in Cancer Research Charlotte Friend Memorial Lectureship.

Catherine Drennan was named to the Searle Scholars Advisory Board.

Gerald Fink was chosen to give the Thomas Roderick Memorial Lecture at the Jackson Laboratory.

H. Robert Horvitz was elected to the National Academy of Inventors.

Richard O. Hynes delivered the keynote address at the North American Vascular Biology Organization annual meeting in Hyannis on October 2015.

Tyler Jacks was named to the John Mendelsohn Visiting Professorship in Cancer Medicine.

Eric Lander was named the recipient of the 2016–2017 James R. Killian Jr. Faculty Achievement Award. He was also the winner of the 2015 Philip Hauge Abelson Prize, which is given by the American Association for the Advancement of Science. He was elected as a fellow of the American Academy of Cancer Research, class of 2016, and received the Han-Mo Koo Memorial Award from the Van Andel Institute.

Mike Laub's scientific contributions and status were recognized by his appointment as a Howard Hughes Medical Institute Investigator.

Douglas Lauffenburger delivered the Van Leeuwenhoek Lecture in Bioscience at the University of Leiden.

Harvey Lodish received the Pioneer Award from the Diamond Blackfan Anemia Association. He also served as distinguished speaker at the University of Copenhagen Faculty of Health and Medical Sciences, Institute of Biological Chemistry, Academia Sinica, Taipei, and at the Moon Shan Biomedical Research Forum at Taipei Medical College.

J. Troy Littleton was named the Menicon Professor of Neuroscience at MIT.

Hidde Ploegh was elected to the National Academy of Sciences.

Terry Orr-Weaver delivered a Distinguished Lecture at the National Institute of Environmental Health Sciences and was the keynote speaker at the Triangle Fly Symposium 2016.

David C. Page was selected as keynote speaker at the Molecules, Cells, and Organisms Graduate Program annual retreat at Harvard University. In addition, he served as the president's featured lecture at the annual meeting of the Association of University Cardiologists annual meeting in St. Petersburg, FL.

Aviv Regev was elected to the International Society for Computational Biology in the 2016 class, and became an editorial board member of *Cell* and *Current Opinion in Systems Biology*.

David Sabatini was elected to the National Academy of Sciences.

Phillip Sharp received an honorary degree from the Scripps Research Institute in La Jolla, CA.

Hazel Sive received the 2016 Alan J. Lazarus Award for Excellence in Freshman Advising.

Frank Solomon received the MIT Committed to Caring Award.

Robert Weinberg received the 2016 Salk Medal from the Salk Institute. He is the 13th recipient of the Lifetime Achievement Award from the American Association for Cancer Research.

Jing-Ke Weng received a Beckman Young Investigator Award and was named an Alfred P. Sloan Research Fellow in Computational and Evolutionary Molecular Biology.

## Research Highlights

Our faculty members continue to make major research contributions to the life sciences. Research areas include genetic information within cells and how it is decoded; the structure and function of the cellular machineries needed for normal growth and propagation; how normal cellular processes work and what goes wrong in disease (e.g., in cancer, neurodegeneration, and infection); how cells differentiate to adopt new fates and functions; how microbes function and interact with each other and with larger organisms to be beneficial or to cause disease; how cells process and respond to external and internal signals; how evolution shaped fundamental biological processes, and what controls aging and regeneration.

Below are research highlights from the three Biology Department faculty members who were promoted to full professor during the 2015–2016 academic year.

Dennis Kim, trained as both a scientist and physician, has developed a highly creative and powerful research program to understand the fundamental mechanisms that determine what makes a multicellular organism resistant or sensitive to infectious disease. The laboratory uses a genetic approach to identify genes required for host survival during microbial infection, finding a role for evolutionarily conserved innate immune signaling pathways in the *C. elegans* defense against pathogenic bacteria. Dr. Kim has made pioneering discoveries affecting such diverse fields as cell biology, immunology, neurobiology, evolution, and human disease.

Michael Laub is interested in information processing within cells— that is, in how cells sense the external and internal environments and then modulate gene expression, structure, motility, and growth in response to these conditions. His work combines genetic, genomic, biochemical, molecular, cell biological, and computational approaches to understanding these fundamental problems in *E. coli* and *C. crescentus*, two experimentally tractable and easily studied bacteria. His scientific contributions and stature were recognized by his appointment as a Howard Hughes Medical Institute Investigator.

Peter Reddien’s research is focused primarily on the process of tissue and organ regeneration, using planaria (flatworms), which have remarkable regenerative capabilities. His laboratory uses an array of methodologies, including high-throughput sequencing, RNAi screening, and numerous assays and tools for phenotypic analysis, to identify and characterize regeneration regulatory genes. Peter’s scientific accomplishments and stature were highlighted and recognized by his appointment as a Howard Hughes Medical Institute Investigator last year.

## Education

Fifth-week enrollment data showed that 98 undergraduates were registered as Biology majors in addition to 16 double majors. There were 83 undergraduate majors working toward the Computer Science and Molecular Biology degree.

The bachelor of science degree was awarded to 44 students in Biology, to 23 students in Computer Science and Molecular Biology, and to 11 students who held a double major.

There were 261 graduate students registered in the Biology Department, with another 22 in the Joint Woods Hole Oceanographic Institute program. The Department awarded 48 PhD degrees and two SM degrees in Biology. Four PhD degrees were awarded in the Joint Program in Biological Oceanography with the Woods Hole Oceanographic Institute.

We are proud of our long-standing focus on excellence in both undergraduate and graduate education. The department's faculty members, regardless of rank, committed to playing an active role in teaching, advising, and mentoring students. The department encourages and supports continued reviews and development of new and existing courses to keep up with the rapid pace of discovery in the life sciences and to adapt to needs and capabilities of our students.

### Online Education Initiatives

Since 2013, we have partnered with the Office of Digital Learning to establish an MITx Biology team (BIOx) of three PhD biologists who have pedagogical training as well as a specific skill set for creating digital learning materials. These individuals are also included in the Digital Learning Lab that President Reif introduced to the MIT community in January 2016. The BIOx team enables the faculty to develop innovative massive open online courses (MOOCs) on the edX platform, and residential materials using MITx, an iteration of the edX platform.

Since the 2013 release (and repetition) of MITx 7.00x Introduction to Biology—The Secret of Life, the department released a self-paced version in July 2015. In spring 2016, the BIOx team developed a comprehensive competency examination, built on the principles of education research, as the sole means of certification in the 7.00x edX course. This exam uses all technical means available to deter and prevent cheating while holding the learners to a high degree of excellence. This is the first exam of its kind released on edX. The trial run went well in July 2016 and we are evaluating and planning for the next release. The department also hopes to use parts of this exam for the MIT General Institute Requirements advanced standing examination (pilot in planning). The first release of the MOOC 7.QBWx Quantitative Biology took place in June 2014, with subsequent releases in January 2015 and March 2016. The team developed and released 7.28.1x Molecular Biology: DNA Replication and Repair for edX (with Professors Steve Bell and Tania Baker) in March 2015, with subsequent releases in August 2015 and June 2016. With the same faculty, the team developed and released 7.28.2x Molecular Biology: Transcription and Transposition in October 2015. This course will be open again in August 2016. With each release of a course, we have had 5,000 to 20,000 edX learners who registered and thousands who engaged with the content. The team is currently working on the final part of the 7.28x Molecular Biology series, RNA Processing and Translation, to be released in late fall 2016.

The department has made significant progress with integrating MITx sites into residential courses and with outreach to provide MIT students with additional learning resources. The BIOx team customizes all digital learning materials created for a MOOC for use in the residential version of the course. Most teaching staff apply the MOOC materials as practice content, and there is significant student activity in some courses.

MITx sites are used in a variety of ways in the Introduction to Biology General Institute Requirements, Molecular Biology, and Cell Biology. In the 7.28/7.58 Molecular Biology residential course, Professor Bell moved to sole use of the MITx site. Some of the online questions were included as part of the grade, and the majority of MIT students who completed the survey thought that this practice should continue; students also said they experienced an improvement in studying and learning as a result of completing the questions.

The BIOx team also creates materials designed specifically for a residential course. In addition to the project designed for 7.06 Cell Biology with Professors Frank Solomon and Adam Martin, the BIOx team started working with Professor Michael Yaffe in spring 2016 to introduce PyMOL (protein structure tool) exercises into the curriculum of 7.05 Biochemistry.

In spring 2016, the lead of our BIOx team, Mary Ellen Wiltrout, received the School of Science Infinite Mile award for her (and her team's) contributions to the department and beyond.

### **Undergraduate Awards**

The Department of Biology takes great pride in the success and productivity of its students, a number of whom received awards in academic year 2016.

#### ***Class of 2016***

Marianna Agudelo: third prize for excellence in German Studies at MIT.

Richard L. Chang: Peter and Sharon Fiekowsky Award for Excellence in teaching at the Experimental Study Group.

Hope Flaxman: three Chemistry Department awards—the Chemistry Research Award, the Merck Index Award for outstanding scholarship, and the Association of MIT Alumnae Senior Academic Award nominee.

Molly McNamara: second place in the S. Klein Prize for Technical Writing.

Sarah Osmulski: first place in the Obermayer Prize and the S. Klein Prize for Technical Writing.

Tanyaporn Pattarabanjird: two Chemistry Department awards—the Chemistry Research Award and Service Award.

John Read: Service Award for outstanding contributions in the area of service to the Chemistry Department.

Paul Schwein: the Richard and Jody Nordlof Award in recognition of distinguished service for musical contribution to the MIT Wind Ensemble, and the Chamber Music Performance Awards in recognition of steadfast commitment to MIT Chamber Music.

Ava Soleimany: the Henry Ford II Scholar Award.

Daniel Sosa: Certificate of Engineering Leadership, which recognizes the successful completion of the requirement of the one-year Bernard M. Gordon–MIT Engineering Leadership Program.

Phi Beta Kappa: Emma Chaloux-Pinette, I-Ling Chiang, William Conway, Chloe Dlott, Hope Flaxman, Jennifer Halford, Patrick Juras, Sharon Kim, Joseph Paggi, Marsha Wibowo, and Amy Zhang.

### ***Class of 2017***

Melanie Abrams: the Vera List Prize for Visual Arts and the Boit Manuscript Prize.

Zi-ning Choo: BP Outstanding Academic Achievement Award (given to a junior woman chemical engineer).

Lei Ding: Barry Goldwater Scholarship.

Shivangi Goel: 2016 Priscilla King Gray Award for Public Service.

Kathleen Johnson: Certificate of Engineering Leadership, which recognizes the successful completion of the requirement of the one-year Bernard M. Gordon–MIT Engineering Leadership Program.

Dina Levy-Lambert: second prize for excellence in German Studies at MIT.

Sophia Liu: honorable mention for the Kelly Essay.

Victoria Xiao: Kelly-Douglas Summer Travel Fellow.

### ***Class of 2018***

Marjorie Buss: BP Outstanding Academic Achievement Award (given to a sophomore woman chemical engineer).

Elizabeth Li: the Dewitt Wallace Prize for Science Writing for the Public.

### ***Biology Department Awards***

Chelsea (Xiao) Chen: John L. Asinari Award for outstanding research in the field of life sciences.

Kimia Ziadkhanpour: Gene Brown Prize for academic scholarship and demonstrated excellence as a teaching assistant.

Rachel Terry: Susan Hockfield Prize in Life Sciences for a third-year MIT undergraduate student in any area of the life sciences who has demonstrated both exceptional performance and promise for graduate study and research.

Jennifer Halford: Ned Holt Prize for demonstrated excellence in scholarship as well as service to the MIT community.

Lauren Bush: Salvador E. Luria Prize for scholarship and research of publication quality.

William Conway: Merck Prize for outstanding research and academic performance in biophysical or bioinformatics sciences.

Maiko Kitaoka: Whitehead Prize for outstanding promise for a career in biological research through academic scholarship as well as contributions to research and the MIT community.

## Undergraduate Research Symposium

Eleven students spoke at the Undergraduate Research Symposium in January at the invitation of their research faculty mentors, including Shi Yun Wang, Erika Arias, Lei Ding, Rachel L. Terry, Ching Pin Cheng, William Conway, Sean Corcoran, Anastassia Bobokalonova, Sarah Osmulski, Xiao Chen, and Alina Li.

## Diversity Initiatives

A strategic objective of the Biology Department is to increase the pipeline of underrepresented minority students pursuing research careers. A primary, but not the sole, focus of these efforts is to increase such students' enrollment in Biology's own graduate programs. To this end, the department engages in a variety of outreach activities, including participation in national conferences for minority scientists and undergraduate students; visits to colleges and universities with large numbers of students from underrepresented minority groups to establish regular and direct contact with students, faculty, and program directors at these institutions; MIT campus visits with underrepresented minority and underprivileged students interested in graduate school in the biological sciences; and opportunities for faculty from institutions primarily serving underrepresented minority groups to perform sabbatical research or to visit and present their research at MIT. A few highlights of activities from academic year 2016 follow.

Professor Amy Keating and two graduate students attended the Annual Biomedical Research Conference for Minority Students (ABRCMS). Dr. Mandana Sassanfar, the department's diversity and outreach coordinator, represented the Biology Department at graduate school fairs at the University of Massachusetts, Boston, and the University of Maryland, Baltimore County. She attended annual meetings of the ABRCMS, of the Society for Advancement of Chicanos/Hispanics and Native Americans in Science, and of the American Association for the Advancement of Science. Dr. Sassanfar also visited a number of diversity-focused programs and biology departments at minority-serving institutions such as Howard University, Hunter College, the University of Puerto Rico, Barry University, Florida International University, and the University of California, Los Angeles.

The Department of Biology continues to be an active participant in the MIT Summer Research Program (MSRP Bio), which is designed to encourage members of underrepresented minorities and underprivileged students to pursue careers in the sciences. Students spend 10 weeks conducting full-time supervised research and participate in classes and other activities designed to prepare them for graduate studies in the biomedical sciences. The summer 2016 program was highly competitive—18 students were selected from a pool of more than 220 applications and another six were accepted through a cost-sharing arrangement with the Howard Hughes Medical Institute. This summer the MSRP Bio students met as a group with a number of Biology faculty, including Professors Bell, Laub, Weng, Amon, Littleton, Reddien, and Alan Grossman, to hear about their research and career paths and receive career advice. In addition, Professors Amy Keating and Michael Hemann, co-directors of the Biology graduate program, conducted mock graduate interviews for 16 students who will apply to PhD programs this coming fall. Professors Frank Solomon and Jacqueline Lees taught

a four-session course to 22 of the participants. Students were also encouraged to contact faculty and arrange for one-on-one meetings.

In January 2016 the department offered the annual week-long Quantitative Methods Workshop for 61 students and faculty from historically black colleges and universities, such as Spelman College and Howard University, and from minority-serving institutions from Puerto Rico and Florida. The intensive, fast-paced workshop exposes participants to quantitative and computational tools required to analyze large biological data sets or model biological phenomena. The participants attended a lecture by Professor Gene-Wei Li, the department's newest faculty member, and met with a number of Biology faculty to learn about their research, career paths, and the process for applying to graduate schools. Eight of this year's participants were selected for the 2016 MSRP Bio program (seven members of underrepresented minority groups and one nontraditional student).

The department started a new semester-long training program for talented members of underrepresented minorities who would benefit from additional rigorous research training in preparation for graduate school. The first trial (January to August 2016) was a great success; Biology hopes to continue and perhaps expand this program. The first student in the program is an African American woman from Haiti who was identified through the 2015 MSRP Bio program. She will apply to PhD programs this fall. The department hopes to recruit her to MIT.

The department organizes high-school outreach programs as well. In March, Biology hosted class field trips for more than 150 high-school students from five Greater Boston area high schools and New Hampshire over a two-day period. These students attended lectures, toured various facilities, and participated in hands-on activities and computer labs led by graduate students. In July, Biology co-hosted the annual summer workshop for high-school science teachers from Massachusetts with the Department of Brain and Cognitive Sciences. During this five-day workshop, teachers participate in hands-on laboratory activities, this year focused on neuroscience, and designed new curricular material for high-school science classes.

The department's programs emphasize personal contact and long-term regular interactions with faculty who mentor members of underrepresented minority groups. This has been an effective recruitment strategy. The department has experienced a steady increase in the percentage of such graduate students, from approximately 5% to 15%, from FY2006 to FY2016. More than 50% of these students have attended at least one of the following programs: MSRP Bio program, Quantitative Methods workshop, or the CONVERGE program, sponsored by the Office of Graduate Education.

## **Development**

In response to the decrease in federal support for research and training, and following the advice of the Visiting Committee, Biology continues to seek funding from individuals and foundations. Given the essential role that graduate students play in virtually all of the department's work, the Graduate Training Initiative, which aims to raise funds to endow graduate fellowships in the department, remains a priority. With

the help of MIT alumnus and former faculty member Paul Schimmel Ph.D. '67, Biology continues to approach department alumni and non-alumni friends to ask their help in enhancing the graduate student experience through student and programmatic support. Over the past year, the Department of Biology has received gifts totaling \$1.5 million from graduates of the department, other School of Science alumni, and local industry leaders. Among those who have supported the Graduate Training Initiative this year are Camille Bedrosian SM '83, Walter Herlihy PhD '79, and Amir Nashat ScD '03, as well as John Maraganore, managing partner of Cardinal Partners, Terrance McGuire, partner of Polaris Partners, and Christoph Westphal, co-founder of Sirtris Pharmaceuticals. Since this effort began, Biology has secured commitments to the Graduate Training Initiative of more than \$16.5 million, and is confident that number will continue to grow.

The department is also seeking funds to support its outreach and diversity efforts, including its flagship program, the Biology MIT Summer Research Program. Because of the loss of a Howard Hughes Medical Institute education grant that provided \$450,000 a year, Biology has begun raising money to endow this program. To date, the department has raised about one-third of the funds necessary, thanks in great part to a \$1 million gift from Michael Gould, whose late father, Bernard Gould '32, was a Biology Department faculty member. Mr. Gould's endowed fund is expected to fully support three students per year.

In partnership with the Office of Foundation Relations and the Office of Sponsored Programs, Biology continues to explore and secure additional sources of nongovernmental support. In general, contributions from foundation and industrial sponsors are small and carry the added complication of under-recovery of overhead. However, the Fidelity Foundation is currently reviewing a formal proposal to help the department establish a cryo-electron microscopy facility at MIT by providing funds to purchase the cryo-electron microscopy instrument itself. While awaiting the result, Biology continues to seek out and engage additional potential sources of support for this project.

### **Named Lectures**

The department welcomed the following named speakers during academic year 2016:

Salvador E. Luria Lecture: Fred Alt, Harvard Medical School

Chipperfield Lecture: George Daley, Children's Hospital

Alexander Rich Lecture: Joel Sussman, Weizmann Institute

Charles "Ned" E. Holt Memorial Lecture: David Relman, Stanford University

Paul F. Glenn Lecture Distinguished Lecture: Jan van Deursen, the Mayo Clinic

Sackler Lecture: Josef Penninger, IMBA, Vienna, Austria

Francis O. Schmitt Memorial Lecture: Axel Brunger, Stanford University

**Alan D. Grossman**

**Praecis Professor**

**Head, Department of Biology**