

## Department of Biology

Academic year 2021 (AY2021) was exciting and productive for the [Department of Biology](#) despite the challenges of the Covid-19 pandemic. The department continues to be considered one of the best biological science departments in the world, and in 2021 our program once again placed second in the QS World University Rankings for Biological Sciences. The department's faculty members are leaders in biological research and education, and its students are among the best. This year, a record-setting number of students accepted offers of admission to the Department of Biology graduate program. Some of the news regarding the department's faculty, research, and educational programs is highlighted below.

### Faculty Count, Promotions, and Departures

During AY2021, the Department of Biology had 59 primary faculty members: 43 full professors, seven associate professors, and nine assistant professors. Research facilities were distributed among the Koch Biology Building, the Broad Institute of MIT and Harvard, the Koch Institute for Integrative Cancer Research, the Picower Institute for Learning and Memory, and the Whitehead Institute for Biomedical Research. An additional five faculty members held secondary appointments in the department. These joint faculty members provided important connections with other departments including Brain and Cognitive Sciences, Biological Engineering, Physics, and Civil and Environmental Engineering.

Lindsay Case joined Biology as a new assistant professor. We also welcomed Ibrahim Cissé, an associate professor of physics with a joint appointment in Biology, though Cissé will be transitioning to a new position at the California Institute of Technology at the end of the summer. Ruth Lehmann, Jonathan Weissman, and Yukiko Yamashita were welcomed to the department as full professors. Lehmann was also elected as the new director of the Whitehead Institute, succeeding Dave Page. Weissman was announced as the Whitehead Institute's inaugural Landon T. Clay Professor of Biology and Yamashita as the inaugural holder of the Susan Lindquist Chair for Women in Science.

Laurie Boyer was promoted to full professor with tenure and Gene-Wei Li to associate professor without tenure.

Several Biology faculty members were appointed to named professorships, receiving additional support to pursue their research and develop their careers. Iain Cheeseman was named the Margaret and Herman Sokol Chair in Biomedical Research; Mary Gehring, an associate professor, was appointed to the Landon T. Clay Career Development Chair; Ankur Jain, an assistant professor, was named the Thomas D. and Virginia W. Cabot Career Development Professor; and Pulin Li, also an assistant professor, was named the Eugene Bell Career Development Professor of Tissue Engineering.

David H. Koch Professor of Biology Tyler Jacks stepped down as director of the Koch Institute for Integrative Cancer Research. Jacks had served as director for more than 19 years and oversaw the evolution of the MIT Center for Cancer Research into the Koch Institute in 2007. Matthew Vander Heiden was elected to succeed Jacks as director effective April 1, 2021.

Aviv Regev, a professor of biology and member of the Broad Institute and Koch Institute, took a leave from her role at MIT to accept a position as executive vice president of Genentech Research and Early Development. Eric Lander, a professor of biology and director of the Broad Institute, also took a leave from MIT after being named the presidential science advisor by President Biden, the first science advisor to serve as a member of the cabinet. Professors Frank Gertler and Lisa Steiner retired.

The department said goodbye in October to Angelika Amon, professor of biology and member of the Koch Institute, after a two-and-a-half-year battle with ovarian cancer.

## Faculty Awards

The department's faculty members are widely recognized for their contributions to the field. The current faculty includes three Nobel laureates, 28 members of the American Academy of Arts and Sciences, 16 fellows of the American Association for the Advancement of Science, five recipients of the National Medal of Science, and 16 Howard Hughes Medical Institute investigators.

The following are some of the recent honors and awards given to Biology faculty members:

- Iain Cheeseman earned a Global Consortium for Reproductive Longevity and Equality Scholar Award from the Buck Institute for Research on Aging. Cheeseman was also named treasurer of ASAPbio, a scientist-driven nonprofit promoting transparency and innovation in life science communication.
- Ibrahim Cissé received the Vilcek Prize for Creative Promise in Biomedical Science.
- Catherine Drennan, a professor of biology and chemistry, was elected a fellow of the American Association for the Advancement of Science. Drennan was also elected to the inaugural class of American Society for Biochemistry and Molecular Biology Fellows. In addition, Drennan and her graduate student Sheena Vasquez were named a 2020 Gilliam Advisor-Fellow pair by the Howard Hughes Medical Institute.
- Mary Gehring's project "A New Approach to Enhance Genetic Diversity to Improve Crop Breeding" was awarded seed funding through the Abdul Latif Jameel Water and Food Systems Lab.
- Nancy Hopkins, Amgen Professor of Biology emerita, was elected to the 2021 class of American Association for Cancer Research Fellows.
- Douglas Lauffenburger, Ford Professor of Biological Engineering, Chemical Engineering, and Biology, was awarded the National Academy of Engineering's Bernard M. Gordon Prize for Innovation in Engineering and Technology Education.
- Ruth Lehmann received the Vilcek Prize in Biomedical Science. Lehmann also was presented the 2020 Francis Amory Prize in Reproductive Medicine and Reproductive Physiology and the 2021 Genetics Society of America's Thomas Hung Morgan Medal for lifetime contributions to the field.

- Gene-Wei Li and Catherine Drennan were recognized by the MIT Committed to Caring program as outstanding and stalwart mentors to their graduate students.
- Pulin Li, an assistant professor and member of the Whitehead Institute, received a New Innovator Award from the High-Risk, High-Reward Research Program of the National Institutes of Health and the R.R. Bensley Award in Cell Biology from the American Association of Anatomy.
- Harvey Lodish, a professor of biology and biological engineering, was one of six instructors honored with the 2021 MITx Prize for Teaching and Learning for excellence in creating MITx massive open online courses. Lodish was also elected as a foreign member of the Royal Academy of Medicine of Belgium.
- Sebastian Lourido, Latham Family Career Development Professor, earned the Award for Early Career Basic Research from the American Society for Microbiology.
- Aviv Regev received the inaugural James Prize in Science and Technology Integration from the National Academy of Sciences. Regev was also elected to the 2021 class of American Association for Cancer Research Fellows and earned the Keio Medical Science Prize.
- Leona Samson, Uncas and Helen Whitaker Professor emerita, was elected to the American Academy of Arts and Sciences.
- Stefani Spranger was named a 2020 Young Investigator by the Society for Melanoma Research.
- Seychelle Vos received a New Innovator Award from the High-Risk, High-Reward Research Program of the National Institutes of Health.
- Robert Weinberg, Daniel K. Ludwig Professor for Cancer Research and member of the Whitehead Institute, was recognized by the Japan Prize Foundation in the Medical Science and Medicinal Science category for achievements in the field of cancer biology.
- Michael Yaffe, David H. Koch Professor in Science, was named one of this year's Margaret MacVicar Faculty Fellows for exemplary and sustained contributions to undergraduate education at MIT. He was also elected to the prestigious Association of American Physicians.

## Research Highlights

MIT's Covid-19 research has continued to dominate the news coming out of the Institute. Basic scientific research conducted at MIT in the 1970s by Institute Professor Phillip Sharp and others laid the groundwork for the approval of the Food and Drug Administration's emergency use authorization of messenger RNA vaccines against Covid-19. Instead of delivering a virus or a viral protein, RNA vaccines deliver genetic information that allows the body's own cells to produce a viral protein. Synthetic mRNA that encodes a viral protein can borrow this machinery to produce many copies of the protein. These proteins stimulate the immune system to mount a response without posing any risk of infection.

Even with the focus on Covid-19, Department of Biology faculty members and students continue to make major research contributions across the life sciences. Research areas include decoding of genetic information within cells, 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 (cancer, neurodegeneration, infection), how cells differentiate to adopt new fates and functions, how microbes function and interact with each other and larger organisms to promote health or cause disease, how cells process and respond to external and internal signals, how evolution shaped fundamental biological processes, and the factors that control aging and regeneration.

Some of the important new technologies created and discoveries made by Department of Biology faculty this academic year are described below.

Lead author and biology graduate student Ellen Zhong published a study in *Nature Methods* (with senior authors Joseph Davis, Biology Whitehead Career Development Assistant Professor, and Bonnie Berger from the Department of Mathematics) on new artificial intelligence–based software for reconstructing multiple structures and motions of imaged protein. Cryo-electron microscopy allows scientists to produce high-resolution, three-dimensional images of tiny molecules such as proteins. This technique works best for imaging proteins that exist in only one conformation, but MIT researchers have now developed a machine learning algorithm that helps them identify multiple possible structures a protein can take.

One way that organisms eliminate unneeded cells is through a process called extrusion, which allows cells to be squeezed out of a layer of tissue without disrupting the layer of cells left behind. MIT biologists have now discovered that this process is triggered when cells are unable to replicate their DNA during cell division. Vivek Dwivedi, a postdoctoral fellow in the department, was the lead author on a paper in *Nature* outlining the group's findings. H. Robert Horvitz, the David H. Koch Professor of Biology, was the study's lead investigator.

Egg cells are by far the largest cells produced by most organisms. In humans, they are several times larger than a typical body cell and about 10,000 times larger than sperm cells. There is a reason why egg cells, or oocytes, are so big: they need to accumulate enough nutrients to support a growing embryo after fertilization, along with mitochondria to power all that growth. A new study on fruit flies conducted by Associate Professor Adam Martin and Jörn Dunkel from the Department of Mathematics reveals that the process through which oocytes grow significantly and rapidly before fertilization relies on physical phenomena analogous to the exchange of gasses between balloons of different sizes.

Over the past decade the CRISPR-Cas9 gene editing system has revolutionized genetic engineering, allowing scientists to make targeted changes to organisms' DNA. While the system could potentially be useful in treating a variety of diseases, CRISPR-Cas9 editing involves cutting DNA strands, leading to permanent changes to a cell's genetic material. In a paper published online in *Cell*, researchers describe a new gene editing technology called CRISPRoff that allows researchers to control gene expression with high specificity while leaving the sequence of the DNA unchanged. The technique was designed by Jonathan Weissman and his collaborators.

## Education

According to AY2021 fifth-week enrollment data, 58 undergraduates registered as regular biology majors. Also, nine students registered as double majors, 61 majored in Course 6-7 (Computer Science and Molecular Biology), and 41 majored in Course 5-7 (Chemistry and Biology).

There were 244 graduate students registered in the Biology Department's graduate program and the interdepartmental microbiology graduate program. The Joint Program in Biological Oceanography with the Woods Hole Oceanographic Institution had eight students.

In AY2021, the department awarded bachelor of science degrees to 28 biology majors, seven chemistry and biology majors, 14 computer science and molecular biology majors, and 10 students with double majors. The department awarded four master of science degrees, two each in biology and computer science and molecular biology.

Doctoral degrees were awarded to 26 biology students and three students in the interdepartmental microbiology graduate program.

The department is proud of its long-standing focus on excellence in both undergraduate and graduate education. Faculty members are committed to playing an active role in teaching, advising, and mentoring students. The department encourages and supports the continued review and development of new and existing subjects to keep up with the rapid pace of discovery in the life sciences and to adapt to the needs and capabilities of its students.

## Online and Remote Education Initiatives

Given the extraordinary pressures of adapting to the realities of the Covid-19 pandemic during AY2021, learners from around the world have increasingly sought out MITx courses to stay intellectually active. In just the first few months of the pandemic, more than 500,000 learners enrolled in these courses.

Promoting evidence-based teaching practices via online education remains a priority for the MITx Biology team, and MITx biology subjects have had an impressive reach. Both 7.00x Introduction to Biology and 7.28.1x Molecular Biology: DNA Replication and Repair were named to the ClassCentral 2020 list of best online courses of all time, two of 200 courses selected out of more than 15,000. Also, Harvey Lodish, Biology Department doctoral student Kate Koch, and co-teachers across the Institute were awarded a 2021 MITx Prize for Teaching and Learning in Massive Open Online Courses for their class 15.480x The Science and Business of Biotechnology.

In addition, scientists affiliated with the Department of Biology developed a new online course, 7.00 Covid-19, SARS-CoV-2 and the Pandemic, aimed at providing students with information on the science of the pandemic. The course, which included a public livestream and recordings, was led by Richard Young, professor of biology and member of the Whitehead Institute, along with Facundo Batista of the Ragon Institute of MGH, MIT, and Harvard. Collectively, the 14 lectures offered through the class garnered more than 500,000 views. The department intends to offer an updated version this fall as our understanding of the virus continues to evolve.

A series of other courses focused on cell biology were added to the EdX platform to build on existing introductory biology and biochemistry online courses. These courses included 7.07.1x Cell Biology: Transport, taught by Professor of Biology Frank Solomon and Robert A. Swanson Career Development Professor Rebecca Lamason; 7.06.2x Cell Biology: Signaling, offered by Solomon and Iain Cheeseman; and 7.06.3x Cell Biology: The Cytoskeleton and Cell Cycle, taught by Cheeseman.

The department also found ways to transform existing courses into an online format due to Covid-19 restrictions, including the IAP class 7.102 Introduction to Molecular Biology Techniques, a hands-on course designed to familiarize first-year undergraduates with lab equipment and basic methods in molecular biology. Mandana Sassanfar, the department's director of outreach, created a remote version of 7.S391 Special Subject in Biology. Students watched videos of graduate students and postdoctoral fellows demonstrating various lab techniques and then described the experiments, compared techniques, and devised protocols based on their observations. Even without the in-person experience, participants will be well prepared to undertake undergraduate research opportunities when in-person instruction returns.

### **Student Awards**

The department takes great pride in the success and productivity of its students, many of whom received recognition in AY2021.

### **External Awards**

- Christian Loyo, a doctoral student in the lab of Alan Grossman, received an honorable mention in the 2021 Ford Foundation Fellowship competition.
- Meghana Kamineni, a senior minor in biology, was awarded a Fulbright Fellowship to research statistical models of Covid-19 spread at the University of Oslo in Norway.
- Five students, three in the undergraduate program and two in the graduate program, were awarded 2021 National Science Foundation Graduate Research Program Fellowships. The awardees were Juana Delao, Nikole Fendler, Agata Bikovtseva, Roberto Bolli, and Harrison Wang.

### **MIT Undergraduate Awards**

- Biology majors Sahithi Madireddy, Vaishnavi Phadnis, Atharv Oak (computer science and molecular biology), Daniel Zhang, and Diane Zhang (computer science and molecular biology) were recognized as 2021 Burchard Scholars for excellence and engagement in the humanities. Chemistry and biology majors Gabriella Aponte, Pedro Colon, Isha Mehrotra, and Westley Wu also were recognized as 2021 Burchard Scholars.
- Seventeen biology majors from the Class of 2021 were nominated to Phi Beta Kappa: Justin Cordero, Patricia Gao, Aditya Jog, Sandhya Kalavacherla, Anna Khoroshilov, Pranav Lalgudi, Eleane Lema, Joanna Lin, Siam Muquit, Ayesha Ng, Sharon Onggo, Alexandra Pouliot, Harrison Wang, Deborah Wen, Kevin Wesel, Thomas Xiong, and Daiyao Zhang.

### Department of Biology Undergraduate Awards

- Adunoluwa Obisesan was presented the John L. Asinari Award for outstanding research in the field of life sciences.
- Joanna Lin and Vaishnavi Phadnis received the Gene Brown Prize for academic scholarship and demonstrated excellence as teaching assistants.
- Sarah Lincoln was awarded the Susan Hockfield Prize 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.
- Phoebe Li and Westley Wu received the Ned Holt Prize for demonstrated excellence in scholarship and service to the MIT community.
- Tee Udomlumleart and Sidney Vermeulen received the Salvador E. Luria Prize for scholarship and research of publication quality.
- Abigail Scott and Stephanie Zhang received the Merck Prize for outstanding research and academic performance in biophysical or bioinformatics science.
- Desmond Edwards was awarded the Whitehead Prize, which recognizes outstanding promise for a career in biological research through academic scholarship as well as contributions to research and the MIT community.

### Chemistry and Biology Undergraduate Awards

- Ana Florescu-Ciobotaru was presented the First-Year Chemistry Achievement Award for outstanding academic achievement in chemistry.
- Alex Li received the Outstanding Sophomore Achievement Award for outstanding achievement in academics, research, and service to the Department of Chemistry.
- Harrison Wang was recognized by Alpha Chi Sigma for outstanding achievement in scholarship, research, and service to the Department of Chemistry.
- Agata Biovtseva, Ameena Iqbal, Dayanne Rolim Carvalho, and Rachel Weissman were recognized for outstanding contributions in the area of research.
- Siam Muquit was recognized for significant contributions in the area of service.
- Eleane Lema, Deborah Wen, and Anna Khoroshilov received the Royal Society of Chemistry Certificate of Excellence for outstanding scholarship.

### Department of Biology Graduate Student Awards

- Erika Weiskopf received the Teresa Keng Graduate Teaching Prize for outstanding dedication and commitment to teaching.
- Kiera Sapp and Christian Loyo were presented the Gene Brown-Merck Teaching Award for outstanding dedication and commitment to teaching.
- Lena Afeyan, Vidit Bhandarkar, Juana Delao, Cesar Dominguez, and Ifrah Tariq received Biology Awards for Excellence in Teaching.

## Undergraduate Research Symposium

Eleven students spoke during the Undergraduate Research Symposium in January at the invitation of their research faculty mentors: Meghan Davis, Wilson Gomarga, Prateek Kalakuntla, Stuti Khandwala, Noopur Ranganathan, Daniel Zhang, Atharv Oak, Sidney Vermeulen, Sarah Lincoln, Sharon Onggo, and Stephanie Zhang.

## Diversity and Outreach

This past summer, as part of the #ShutDownSTEM, #ShutDownAcademia, and #Strike4BlackLives national initiative, members of the Department of Biology took a day to engage in open conversations about racial bias, diversity, and inclusion. Postdoctoral fellows, staff, and trainees organized the #ShutDownSTEM.MITbio program, providing 13 virtual sessions on topics ranging from allyship and white privilege to antiblackness and racism in science. Forty-five members of the department volunteered to help facilitate, and more than 200 participated throughout the course of the day. The event marked the beginning of what the organizing committee and department hope will become substantive action to combat racism and build a more equitable and inclusive community within the department.

In addition, the department hired Hallie Dowling-Huppert as a full-time diversity, equity, and inclusion (DEI) officer. As the DEI officer, Dowling-Huppert will work directly with students, faculty, and staff to identify and implement mechanisms and programs that support and promote equity and inclusion. Dowling-Huppert will work closely with Mandana Sassanfar to make the department a welcoming and supportive place to work.

A strategic objective of the Biology Department is to increase the number of students from underrepresented minority groups pursuing research careers. A primary, but not the sole, focus of the department's efforts is to increase enrollment of such students in its graduate programs. To this end, the department continued to engage in a variety of outreach activities and programs for undergraduates who are not at MIT, high school students, and high school teachers during AY2021. Two initiatives in particular serve as robust pipelines for the identification and development of students of diverse backgrounds: the MIT Summer Research Program in Biology (MSRP-Bio) and the Quantitative Methods Workshop.

MSRP-Bio is designed to encourage underprivileged students and students from underrepresented minority groups to pursue careers in the sciences. In AY2021, students spent 10 weeks conducting full-time supervised research and participated in activities specifically designed to prepare them for graduate-level classes. Six MSRP-Bio alumni accepted offers to begin graduate studies in the Department of Biology next year.

The one-week Quantitative Methods Workshop during Independent Activities Period (IAP) brought together 80 students and faculty from historically Black colleges and universities across the United States and Puerto Rico. This intensive, fast-paced workshop (offered remotely this year due to Covid-19 restrictions) exposed participants to quantitative and computational tools and included virtual tours and remote conversations with MIT faculty members.



These two programs and the department's emphasis on personal contact and long-term regular interactions with faculty who mentor students from underrepresented minority groups have proven to be very effective recruitment strategies.

The department also continued the LEAH Knox Scholars Program, a five-week summer program providing mentorship and hands-on lab experience in biology for low-income high school students. This year, because of the Covid-19 pandemic, students were unable to conduct lab work on campus. Instead, Sassanfar and technical instructor Vanessa Cheung partnered with MIT's Edgerton Center to develop at-home kits to allow participants to practice basic lab techniques from the safety of their own homes.

This past year, Nancy Hopkins was featured in a newly released documentary, *Picture a Scientist*, highlighting gender inequality in science. Hopkins helped catalyze the groundbreaking 1999 public report on the status of women at MIT and spoke in the film about her efforts to champion underrepresented voices in science. Hopkins also worked with fellow professors Susan Hockfield and Sangeeta Bhatia to launch the Future Founders Initiative, designed to increase the number of female faculty members who start biotechnology companies.

In addition, the department continued its *BioGenesis* podcast in collaboration with the Whitehead Institute to highlight graduate student research and experiences. The podcast is part of a larger effort to share the personal stories behind scientific discovery and demonstrate the importance of fundamental biology research in the MIT community and beyond.

## Development

Fiscal year 2021 (FY2021) was historic for the Biology Department and broader life science efforts at MIT. The department secured the largest single gift in its history, a \$50 million gift establishing the Schimmel Family Program for Life Sciences. The gift was the largest made to the Institute in FY2021 and served as the capstone gift to the MIT Campaign for a Better World, helping the Institute pass the \$6 billion mark. The gift also contained a matching element seeking a total of \$100 million in support of the newly established program.

The challenges of the pandemic presented the department with the opportunity to pivot its annual Friends of Biology gathering to a virtual format, allowing members of the biology community from across the globe to gather and celebrate the department's many accomplishments. This gathering proved to be the largest in the event's history, with 195 attendees from 12 countries represented. The video of the event continues to draw additional viewership through the Biology Department's website and YouTube page, with more than 1,200 views and counting.

Every year, MIT challenges its alumni and friends to support its educational programs and research enterprise by giving during a 24-hour window in March. This year friends and alumni of the School of Science stepped up to the challenge and placed the school second overall in fundraising led by Department of Biology alumna Dyann Wirth, who served as the challenger for the School of Science. As the 24-hour challenge unfolded,

Wirth set an ambitious goal: if 150 donors gave to the School, she would provide a gift of \$50,000, and if an additional 150 donors joined the effort she would double her gift. The School of Science surpassed both marks as donors, friends, and alumni heeded Wirth's inspiring call to action.

At the end of the fiscal year in June 2021, the Department of Biology also secured a generous gift renaming the MIT Summer Research Program in Biology, which, as noted, encourages underprivileged students and those from underrepresented minority groups to pursue careers in the sciences. The gift will supplement the existing Bernard S. and Sophie G. Gould Fund, created in 2015 in honor of former biology faculty member Bernard Gould and wife, Sophie. Together, these donations will enable many undergraduate students from outside MIT who are interested in a career in life science to participate in the program. The program will henceforth be known as the Bernard S. and Sophie G. Gould MIT Summer Research Program in Biology. Since the program's founding in 2003, 45 former participants have subsequently enrolled in graduate studies within the Department of Biology.

Although this year's development efforts will undoubtedly have historic positive impacts on the sustainability of the graduate program, the Department of Biology remains focused on increasing the number of donors and overall base of support for the department and seeking larger gifts to support our targeted and long-term needs.

**Alan D. Grossman**  
**Department Head**  
**Praecis Professor of Biology**