

## Department of Biology

Academic year 2020 was exciting and productive for the [Department of Biology](#), which continues to be considered one of the best biological science departments in the world. Its faculty members are leaders in biological research and education. Biology placed second in the QS World University Rankings for 2020 for biological sciences, and the department received a record number of applications (1,087) for graduate study. Highlights of the department's faculty, research, and educational programs appear below.

### Faculty

During AY2020, the Department of Biology had 58 primary faculty members: 42 full professors, five associate professors, and 11 assistant professors. Research facilities were distributed between the Koch Biology Building (Building 68), 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 Biology. These joint faculty members provided important connections with other departments, including Brain and Cognitive Sciences, Biological Engineering, and Civil and Environmental Engineering.

The department welcomed Pulin Li (also a newly appointed member of the Whitehead Institute) and Seychelle Vos as assistant professors. Mary Gehring was promoted to associate professor with tenure, and Jing-Ke Weng and Omer Yilmaz were promoted to associate professor without tenure.

Several faculty members were appointed to named professorships, thus receiving additional support to pursue their research and develop their careers. Joseph Davis was named the Whitehead Career Development Professor, and Sebastian Lourido became the new Latham Family Career Development Professor. Elly Nedivi, a professor in both Biology and Brain and Cognitive Sciences, was named the inaugural William R. (1964) and Linda R. Young Professor.

Professors Frank Gertler and Hazel Sive (Koch Institute and Whitehead Institute, respectively) are now professors emeriti of the department. Sive left in June 2020 to become dean of Northeastern University's College of Science.

The department was saddened by the death in January of Maurice Sanford Fox, professor emeritus and former head of the department, as well as the deaths in April of Robert Rosenberg and Arnold Demain, both professors emeriti.

### Faculty Awards

The department's faculty members are widely recognized for their contributions to the field. The current faculty includes three Nobel laureates, 30 members of the National Academy of Sciences, 27 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.

Below are some of the honors and awards given to Biology faculty members in AY2020:

- Angelika Amon, the Kathleen and Curtis Marble Professor in Cancer Research and a member of the Koch Institute, was named one of the Carnegie Corporation of New York's 2019 list of 38 Great Immigrants, Great Americans. Amon was also awarded the Human Frontier Science Program's 2020 Nakasone Award.
- Eliezer Calo, assistant professor, received four years of funding through the Pew Scholars Program in the Biomedical Sciences. Calo, an alumnus of the Bernard S. and Sophie G. Gould MIT Summer Research Program (MSRP-Bio) in Biology, was also an invited speaker at the Annual Biomedical Research Conference for Minority Students.
- Catherine Drennan, professor of biology and chemistry and investigator in the Howard Hughes Medical Institute, was selected to the American Academy of Arts and Sciences. Drennan also received the 2020 Dorothy Crowfoot Hodgkin Award from the Protein Society.
- Gerald Fink, the Margaret and Herman Sokol Professor in Biomedical Research, was awarded the Genetic Society of America's Thomas Hunt Morgan Medal.
- Mary Gehring, associate professor, was awarded a 2019 Bose Award.
- Tyler Jacks, the David H. Koch Professor of Biology, received the 2020 American Association for Cancer Research Princess Takamatsu Memorial Lectureship.
- Ankur Jain, assistant professor and member of the Whitehead Institute, was awarded the David and Lucile Packard Foundation Fellowship for Science and Engineering. Jain also received a Young Alumni Achiever's Award from the Indian Institute of Technology Kharagpur, his undergraduate institution.
- Douglas Lauffenburger, the Ford Professor of Biological Engineering was elected as a fellow of the American Association for the Advancement of Science.
- Troy Littleton, the Menicon Professor of Neuroscience in the departments of Biology and Brain and Cognitive Sciences, received the Department of Brain and Cognitive Sciences Award for Excellence in Undergraduate Advising
- Harvey Lodish, professor of biology and biomedical engineering, received the 2020 Donald Metcalf Award.
- David Sabatini, professor of biology and member of the Whitehead Institute and Koch Institute for Integrated Cancer Research, received a BBVA Foundation Frontiers of Knowledge Award. Sabatini also earned the Louisa Gross Horowitz Prize from Columbia University, the American-Italian Cancer Foundation's 2019 Prize for Excellence in Medicine, and the Royal Swedish Academy of Sciences' Sjöberg Prize.
- Hazel Sive, professor emeritus, received the Institute's Teaching Prize for Undergraduate Education, MIT's highest undergraduate teaching award.
- Phillip A. Sharp, professor of biology and a Nobel laureate, was awarded the 17th American Association for Cancer Research Award for Lifetime Achievement in Cancer Research.

- Stefani Spranger, assistant professor, was selected to join the Pew-Stewart Scholars Program for Cancer Research.
- JoAnne Stubbe, professor emeritus, was awarded the 2020 Priestley Medal by the American Chemical Society.
- Richard Young, professor and Whitehead Institute member, was elected to the National Academy of Medicine.

This year, the School of Science added a one-time staff award that went to Mary Ellen Wilttrout, the department's director of blended and online initiatives. Additionally, the school's Covid-19 Heroes Award went to 25 individuals and groups nominated by peers in recognition of their extraordinary efforts to enable a smooth transition to remote work during the pandemic crisis.

### Research Highlights

Biology Department 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 (cancer, neurodegeneration, infection, and so on); how cells differentiate to adopt new fates and functions; how microbes function and interact with each other and 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 some of the important new technologies and discoveries made by Department of Biology faculty this academic year.

Barbara Imperiali, Class of 1922 Professor of Biology and Chemistry, together with other scientists from MIT, devised a rapid and generalizable way to extract, purify, and label membrane proteins for imaging without impacting the structure or function of the cell membrane. By combining well-established chemical and biochemical techniques in a new way, researchers efficiently isolated and then imaged membrane proteins from the foodborne pathogen *Campylobacter jejuni*.

Research from Sebastian Lourido, the Latham Family Career Development Assistant Professor of Biology and member of the Whitehead Institute, along with graduate student Benjamin Waldman has identified a single gene that creates a protein product which is the master regulator of the trigger that causes the parasite *Toxoplasma gondii* to transition to its chronic stage, causing toxoplasmosis—a potentially deadly disease for the immunocompromised and for developing fetuses. Their findings may prove valuable for eliminating toxoplasmosis, as preventing the parasites from transitioning keeps them susceptible to both treatment and removal by the body's immune system.

Associate Professor Adam Martin, in collaboration with Jörn Dunkel, the Robert E. Collins Distinguished Scholar in the Department of Mathematics, discovered a key mechanism that helps explain reproducibility of tissue folding in embryonic

development. A network of proteins connected like a fishing net creates alternative pathways that tissues can use to fold the right way.

Using cryo-electron microscopy, JoAnne Stubbe and Catherine Drennan were able to freeze and study the detail of the enzymatic activity of ribonucleotide reductase (RNR), which is responsible for converting RNA building blocks into DNA building blocks. Because RNR is a target for anti-cancer therapies and drugs that treat viral diseases like HIV/AIDS, knowing its active-state structure could help researchers devise more effective treatments.

Michael Yaffe, David H. Koch Professor of Science, member of the Koch Institute for Integrative Cancer Research, and director of the MIT Center for Precision Cancer Medicine, led investigations into repurposing a drug commonly given to people who have had a heart attack or stroke to help address Covid-19 patients who have a profound disorder of blood clotting that contributes to respiratory failure.

Beginning in March 2020, the department's Covid-19 research dominated the news coming out of MIT.

In May 2020, the Massachusetts Consortium on Pathogen Readiness, based at Harvard Medical School, announced more than \$16.5 million in funding to support Covid-related research. Professor of biology Jianzhu Chen was awarded funding for a project to enhance mRNA-based coronavirus vaccines. Bruce Walker, a core member of the Phillip T. and Susan M. Ragon Institute, received an award for his research focusing on an exosome-based SARS-CoV-2 vaccine.

## **Education**

Fifth-week enrollment data for AY2020 showed 66 undergraduates registered as regular Biology majors. There were also 12 students with double majors, 65 students majoring in Course 6-7 (Computer Science and Molecular Biology), and 37 students majoring in Course 5-7 (Chemistry and Biology), for a total of 180 students.

There were 244 graduate students registered in the Biology Department's graduate program and in the interdepartmental Microbiology graduate program. The MIT-Woods Hole Oceanographic Institution (WHOI) Joint Program in Oceanography/Applied Ocean Science and Engineering had eight students, for a total of 252.

In AY2020, the department awarded the bachelor of science degree to 64 students, including 30 in Biology, 11 in Chemistry and Biology, 17 in Computer Science and Molecular Biology, and six who had double majors. The department awarded two master of science degrees, one in Biology and one in Computer Science and Molecular Biology.

Doctoral degrees were awarded to 44 students, including 35 in Biology, seven in the interdepartmental Microbiology graduate program, and two in the Joint Program in Biological Oceanography with WHOI.

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.

During the Independent Activities Period, the Department of Biology continued to offer its seminar series to highlight cutting-edge research in biology. This year's seminar series, put together by student leaders and led by Omer Yilmaz, was organized around the theme of microbes in health and disease.

### **Online Education Initiatives**

Promoting evidence-based teaching practices via online and hybrid education continues to be a priority for the MITx Biology team, both in building massive open online courses (MOOCs) on the edX platform (available to learners around the world) and in developing materials specifically for use on campus using MITx, an iteration of the edX platform.

The MITx Biology subjects on edX have had an impressive reach, and the department continues to expand blended-learning initiatives. 7.00x Introduction to Biology was named one of Class Central's Top 100 MOOCs of All Time. Mary Ellen Wiltrout led a workshop at the Reimagine Education conference in London that was named a Silver Winner in the Science of Learning category.

A brand-new course for undergraduates, 7.341 DNA's Sister Does All the Work: The Central Roles of RNA in Gene Expression, was offered on OpenCourseWare by Marvin Jens and Ana Fiszbein, former postdoctoral fellows in the lab of Professor Christopher Burge. Teaching students to look at all the details in existing research literature lest a major discovery reveal itself from those overlooked aspects, the course largely focuses on RNA studies.

On campus, the department continues to expand blended-learning initiatives (digital and in-person teaching and learning) by integrating MITx websites into subjects. The MITx websites host the digital learning materials as assignments or additional resources that in turn influence the in-person learning experience. These kinds of digital resources provided invaluable preparation for when all instruction moved to a remote environment after March 2020, and the department's digital learning team gained a host of new responsibilities. The outreach team even crafted a remote version of MSRPx-Bio to welcome the upcoming year's cohort of students remotely.

### **Student Awards**

The department takes great pride in the success and productivity of its students, many of whom received recognition in academic year 2020.

### **External Awards**

- Vaishnavi Phadnis, a second-year student in computer science and molecular biology, was awarded a Barry M. Goldwater Scholarship, a highly competitive scholarship awarded on the basis of academic merit to support future leading scientists, engineers, and mathematicians.

- Marian Dogar, a senior majoring in biology with a minor in urban studies and planning, was awarded a Schwarzman Scholarship to undertake a one-year master's degree in global affairs at Beijing's Tsinghua University.
- Kristina Lopez, a first-year graduate student in the lab of Whitehead Career Development Professor Kristin Knouse, received a Ford Foundation Fellowship, an award designated by the National Academy of Sciences and funded by the Ford Foundation to encourage diversity in education.

### ***MIT Undergraduate Awards***

Eleven Biology majors from the class of 2020 were elected to Phi Beta Kappa: Delaney Burns (double major with Chemical Engineering), Crystal Chang, Lauren Clamon, Joseph Raymund Espiritu, Apolonia Gardner, Karen Gu (double major with Electrical Engineering and Computer Science), Kathryn Lawrence (double major with Physics), Laura Liao, Maia Mesyngier, Amanda Putnam, and Samuel Solomon (Chemistry and Biology, double major with Physics).

### ***Department of Biology Undergraduate Awards***

- Cynthia Abby Harris, Miguel Aguilar Ramos, and Wilson Gomarga were awarded the John L. Asinari Award for outstanding research in the field of life sciences.
- Daniel Zhang received the Gene Brown Prize for academic scholarship and demonstrated excellence as a teaching assistant.
- Tee Udomlumleart was awarded the Susan Hockfield Prize, which is 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.
- Julia Cho and Ayesha Ng received the Ned Holt Prize for demonstrated excellence in scholarship and service to the MIT community.
- Laura Liao and Madeleine Kline received the Salvador E. Luria Prize for scholarship and research of publication quality.
- Venkatesh Sivaraman received the Merck Prize for outstanding research and academic performance in biophysical or bioinformatics science.
- Leah McKinney was awarded the Whitehead Prize for 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***

- Jeffrey Shi was awarded the Freshman 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.
- Chun-Ting Liu, Samuel Solomon, and Sherry Zhou were recognized for outstanding contributions in research.

- Madeleine Kline, Leon Yim, and Sherry Zhou received the Royal Society of Chemistry Certificate of Excellence for outstanding scholarship.

### **Department of Biology Graduate Student Awards**

- Gerardo Perez Goncalves received the Teresa Keng Graduate Teaching Prize for outstanding dedication and commitment to teaching.
- Arish Shah was awarded the Gene Brown-Merck Teaching Award for outstanding dedication and commitment to teaching.
- Rachel Anderson, Manraj Gill, Acer Xu, Kevin Gozzi, Molly Wilson, Peter Wang, and Mirae Parker received the Biology Awards for Excellence in Teaching.
- Grace Johnson received the Weintraub Graduate Student Award.

### **Undergraduate Research Program**

Ten students—Fatima Gunter-Rahman, Ayesha Ng, Leah McKinney, Abby Harris, Tee Udomlumleart, Harrison Wang, Maia Mesyngier, Vaishnavi Phadnis, Andrea Garmilla, and Muskaan Aggarwal—spoke in the Undergraduate Research Symposium in January at the invitation of their research faculty mentors.

### **Diversity and Outreach**

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 AY2020. Two programs in particular serve as robust pipelines for the identification and development of students with more diverse backgrounds:

- Summer Research Program in Biology (MSRP-Bio): This program is designed to encourage students from underprivileged backgrounds and underrepresented minority groups to pursue careers in the sciences. Students spend 10 weeks conducting full-time supervised research and participated in activities specifically designed to prepare them for graduate-level classes. Since 2003, 450 students have participated in the program under the leadership of Mandana Sassanfar, a biology lecturer in charge of the department's diversity and outreach programs. In that time, nearly 70 program alumni have continued their research as graduate students at MIT. In summer 2019, the program hosted 24 undergraduates from institutions outside of MIT, and six program alumni won prizes for poster presentations at the Annual Biomedical Research Conference for Minority Students.
- Quantitative Methods Workshop: This one-week workshop brought 75 students and faculty from historically black colleges and universities, such as Spelman College and Howard University, and minority-serving institutions from Puerto Rico and Florida, to MIT during Independent Activities Period. This intensive, fast-paced workshop exposed participants to quantitative and computational tools required to analyze large biological data sets or to model biological phenomena.

These two programs, and the department's emphasis on personal contact and long-term interactions with faculty who mentor students from underrepresented minority groups, have proven to be a very effective recruitment strategy. Ten seniors who participated in MSRP-Bio in the summer planned to apply to MIT for graduate school.

There are additional outreach programs overseen by the department on the MIT campus or at one of its other research locations that welcome either undergraduates or younger students and their teachers. These programs are designed in the hope of increasing the diversity of students in the sciences, technology, engineering, and mathematics, and in increasing public awareness of biological and biomedical research.

The summer of 2019 marked the third anniversary of the LEAH Knox Scholars Program, a five-week program for local, low-income high school students that provides hands-on lab experience and a foundation for careers in science. This summer's cohort included 23 sophomores from Everett, Cambridge, and Boston public schools.

Many members of the Department of Biology participated in these programs during AY2020, as well as in other events, including MIT field trips, summer workshops for teachers, the Whitehead Institute Seminar Series for High School Teachers, the Whitehead Summer Science Program for Middle School Students, the Koch Institute Student Outreach Program, the Koch Institute's with/in/sight public lecture series, and the Broad Summer Research Program, Broad Summer Scholars Program, Broad Institute Middle School Program, and Broad Institute public lectures. The department invited 16 instructors from Massachusetts public schools to attend the annual Summer Workshop for Teachers in mid-July, which focused this year on topics in neuroscience.

In collaboration with the Whitehead Institute, the department launched "BioGenesis," a podcast highlighting affiliated graduate students that describes their stories, their origins, and how their experiences have shaped their research. Each episode is co-hosted by Raleigh McElvery, the department's communications coordinator, and Conor Gearin, a digital and social media specialist at the Whitehead Institute. "BioGenesis" 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**

During fiscal year 2020, the Biology Department received the largest number of gifts from individuals in its history, increasing overall participation across all levels of giving among alumni, parents, staff, faculty, and unaffiliated supporters. The department also established a new graduate fellowship that will support a student in perpetuity, with a preference for an alumnus of the department's MSRP-Bio program.

Discretionary funding and support for Biology's graduate program remain the department's top two development priorities. This is particularly critical as, after 45 years of continuous funding, the National Institutes of Health unfortunately reduced the value of the department's annual training grant, which historically has provided support for a significant portion of graduate students. Despite this diminished source of funding, the department continues to be successful in supporting its students and funding a world-class graduate program.



In October 2019, members of the MIT biology community came together to celebrate the many successes of the department during the second annual Friends of Biology reception. Guests included alumni, parents, supporters, industry representatives, faculty, Institute leadership, and students.

When MIT announced its pandemic policies and all in-person events were canceled, the department transformed its third annual Science Slam into a virtual event in partnership with MIT's Alumni Association. In April, almost 300 attendees gathered via Zoom to hear nine graduates from the Departments of Biology and Chemistry share their research in a compelling, accessible manner in short presentations. The Alumni Association donated a total of \$2,000 to MIT's Covid-19 research funds in honor of the three winners. Maya Jay '18, a double major in biology and brain and cognitive sciences, who is a current graduate student in neuroscience at Harvard, won first place and audience favorite.

The Biology Department remains focused on increasing the number of donors and the overall base of support for the department while continuing to seek larger gifts to support Biology's targeted and long-term needs.

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