

## Department of Biology

The [Department of Biology](#) is widely recognized as one of the best biological sciences departments in the world. This is evidenced by our standing as a premier educator of biologists, and as a world leader in biological research ranging from biophysics to developmental and cancer biology.

### Department Demographics

The department has 57 primary faculty members who work in five research locations: Building 68 (24), the Whitehead Institute (16), the David H. Koch Institute for Integrative Cancer Research (13), the Broad Institute (2), and the Picower Institute for Learning and Memory (2). Joint and adjunct faculty provide important connections to other departments, including Brain and Cognitive Sciences, Chemistry, Physics, Biological Engineering, and Civil & Environmental Engineering. The department has three living Nobel Prize winners, 29 National Academy of Science members, 10 Howard Hughes Medical Institute (HHMI) Investigators, three HHMI Early Career Investigators, and five National of Medal of Science winners.

A total of 206 undergraduates registered as biology majors (Course 7 and 7-A) during fall 2011 and spring 2012. There were 35 undergraduates registered as Course 6-7 majors. In spring 2012, 39 freshmen declared biology (Course 7 or 7-A) as their major and 18 freshmen declared biology and computer science (Course 6-7).

The bachelor of science degree was awarded to 72 students from September through June. Of these, 57 were in Course 7, 14 were in Course 7-A and one was in Course 6-7.

From July 1, 2011 to June 30, 2012, the department awarded 33 PhD degrees and four SM degrees in biology. One PhD degree was awarded in the joint program in biological oceanography with the Woods Hole Oceanographic Institution. There were 214 graduate students registered in the biology department in academic year 2012 with another 25 in the joint Woods Hole program.

### Diversity

The department values diversity and inclusion and is committed to expanding the recruitment of underrepresented minorities. Due to the extraordinary efforts of Dr. Mandana Sassanfar we have increased the size of our MIT Summer Research Program. In addition, our other outreach initiatives are flourishing.

We remain very enthusiastic about the Biology & Biotechnology Bridge Program, or B<sup>3</sup> (B-cubed), a two-year post-baccalaureate program based on collaboration between the biology department and Novartis Institutes for Biomedical Research. The goal of the B<sup>3</sup> program is to provide additional research and academic preparation to talented and driven individuals from underrepresented minority and economically disadvantaged backgrounds to prepare them for the country's most competitive biological and biomedical PhD programs. The academic portion of the program takes place at MIT

while the research training portion currently takes place at Novartis. Our students are assigned an academic mentor (professor Mary Lou Pardue), a technical instructor (MIT graduate Erika Lowden), and Novartis scientist research mentors. The first class graduated in June. Efforts are under way to add another biotech/industry partner.

### **MIT Summer Research Program**

For the 2012 summer program, the application process was redesigned to become fully electronic. Eighteen students were selected from a pool of about 300 applicants. Another five students were accepted through cost sharing with HHMI.

In addition, the program hosted two Khorana scholars from India through collaborative efforts with the University of Wisconsin–Madison. The Khorana Scholars Program was established to honor the memory of professor Gobind Khorana who passed away in November 2011. We hope to continue our collaboration with the University of Wisconsin–Madison and to create a Khorana graduate fellows program to support one graduate student each year from India or Nepal.

The continued recent success of the MIT Summer Research Program is demonstrated by the high percentage of students who are later admitted to top US graduate schools and who receive graduate fellowships.

### **Additional Outreach Activities**

Our general efforts to increase diversity in science include a program of HHMI Special Research Seminars. Faculty members are selected to speak because they have a strong impact on their undergraduate programs, can influence undergraduate curriculum development, and/or are undergraduate research program directors/mentors at their institutions. This past year we hosted speakers from Howard University, The City University of New York, Arizona State University, and the University of Puerto Rico. We also have a program for summer sabbaticals for underrepresented minority faculty visitors.

This was the third consecutive year we held a weeklong Independent Activities Period (IAP) intensive Quantitative Biology Workshop. The workshop drew close to 50 students and faculty from the following minority-serving institutions: University of Puerto Rico at Rio Piedras, University of Puerto Rico at Mayaguez, Barry University, Bethune-Cookman University, Hunter College, York College, Howard University, Spelman College, Florida International University, and the University of Maryland. The workshop offered daily research seminars (each introducing a specific method and topic in biology), daily reading of primary literature teaching students how to dissect and critically evaluate research papers, an introduction to quantitative biology, and exposure to cutting-edge technology in a laboratory setting. Participating faculty included Frank Solomon, Amy Keating, Chris Burge, Michael Laub, Mark Bath, and Alan Grossman.

## Education

The Department of Biology is proud of its long-standing reputation for preeminence in the fields of undergraduate and graduate education. All of our faculty, regardless of rank, are committed to playing an active role in teaching, advising, and mentoring our students. The department encourages and supports continued revision of course content, as well as the development of new subjects to keep up with the rapid pace of discovery in the life sciences and to adapt to the needs and capabilities of our students.

## Student Awards

We take great pride in the success and productivity of our students, a number of whom received awards in academic year 2012.

### *Class of 2012*

Biafra Ahanonu from Tucson, AZ, received the Walle J. H. Nauta Award for Outstanding Research in Brain and Cognitive Sciences.

Ryan Alexander from Birmingham, AL, was awarded the Ned Holt Prize for demonstrated excellence in scholarship as well as service to the MIT community.

Allison Alwan from Andover, MA, received the John L. Asinari Award for outstanding research in the field of life sciences from the MIT Department of Biology.

Shion An from Los Angeles, CA, who double majored in biology and chemistry, received several awards, including the Chemistry Research Award, the Frederick D. Greene Teaching Award, and the Merck Index Award.

Timothy Chang from Rego Park, NY, received the Chemical Engineering Special Service Award.

Benson George from East Meadow, NY, won a Philip A. Trussell Prize, which is awarded to a student athlete who demonstrates skill, sportsmanship, and levity for volleyball.

Allison Hamilos from Medfield, MA, won second prize in the DeWitt Wallace Prize for Scientific Writing for the Public and the Chemistry Department's Merck Index Award.

Nora Hickey from McFarland, WI, was awarded the Emerson Music Fellowship.

Paul Jaffe from Arlington, MA, was awarded an Everett Longstreth Jazz Award.

Joy Yunxin Jiao received the Chemical Engineering Department's Wing S. Fong Memorial Prize, which is awarded to a chemical engineering senior of Chinese descent with the highest cumulative GPA. Jiao also was awarded the department's Phi Beta Kappa award.

Thaís Terceiro Jorge from Fortaleza, Brazil, took third prize in the Lufthansa Prize for excellence in German studies.

Evgeny Kiner from the Czech Republic was awarded the Ned Holt Prize for demonstrated excellence in scholarship as well as service to the MIT community from the MIT Department of Biology.

Kamena Kostova from Bulgaria was this year's recipient of the Biology Department's Salvador E. Luria Prize for scholarship and research of publication quality.

Kateryna Kozyrytska from the Ukraine was awarded the Merck Prize for outstanding research and academic performance in biophysical or bioinformatics sciences from the MIT Department of Biology.

Kenneth Lin of Castro Valley, CA, won second prize in the S. Klein Prize for Technical Writing.

Stephanie Lin from Irvine, CA, was awarded a Rhodes Scholarship. She was also named one of the Public Service Center's Fall 2011-IAP 2012 Student Leaders in Service.

Bohan Liu from Quincy, MA, was awarded a Public Service Center IAP 2012 grant.

Victoria Lu from Monterey Park, CA, received the Whitehead Prize for outstanding promise for a career in biological research through academic scholarship as well as contribution to research and the MIT community from the MIT Department of Biology.

Ambar Mehta from Coral Springs, FL, was named a 2011 IDEAS Global Challenge winner for InnoBox Science and Engineering Kit.

Allis Kate Phillips from Herndon, VA, received the John L. Asinari Award for outstanding research in the field of life sciences.

Zoe Rogers from Santa Monica, CA, received a Bridge Builder Award from the Student Activities Office.

Mariya Samoylova from Englewood Cliffs, NJ, won the Literature Department's Peter S. Donaldson Prize for Excellence in Literary Studies.

Stephanie Senna from Jakarta, Indonesia, received the John L. Asinari Award for outstanding research in the field of life sciences from the MIT Department of Biology.

Sumi Sinha from Nashua, NH, received from the fraternities, sororities and independent living groups a Senior Legacy Award of the Kappa Alpha Theta.

Dordaneh Sugano from New York, NY, received an honorable mention from the Department of Brain and Cognitive Sciences for Outstanding Research.

Anupong Tangpeerachaikul from Thailand received the Alpha Chi Sigma Award for distinguished scholastic achievement, originality, and breadth of interest in chemistry. She also received the Randolph G. Wei Undergraduate Research Opportunities Program Award presented by the Office of Undergraduate Advising and Academic Programming to the undergraduate who has made the most outstanding contribution in undergraduate research at the interface of life sciences and engineering. She also won a Public Service Center Fall 2011 grant.

Sasha Targ from Palo Alto, CA, received a Bridge Builder Award from the Student Activities Office.

Twenty biology majors from the class of 2012 were elected to Phi Beta Kappa: Jessica Agatstein, Stephanie Chen, Tiffany Chen, Avital Fischer, Allison Hamilos, Joy Yunxin Jiao, Jun Kim, Evgeny Kiner, Kamena Kostova, Stephanie Lin, Ambar Mehta, Eleanor Phillips, Zoe Rogers, Stephanie Senna, Sumi Sinha, Anupong Tangpeerachaikul, Sasha Targ, Grace Taylor, Anjali Thakkar, and Christina Welsh.

### ***Class of 2013***

Hamsika Chandrasekar from Sugarland, TX, was awarded a Public Service Center IAP 2012 Fellowship.

Nikita Consul from Canton, MI, participated in IAP 2012 Teach for America.

Charles Hsu from Taipei, Taiwan, was a 2011 IDEAS Global Challenge winner for Safe Water World.

Christine Lai, a biology major from Acton, MA, was awarded a MISTI Sun Fellowship. She also received the Susan Hockfield Prize in Life Sciences, which is awarded to 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 from the MIT Department of Biology.

Janet Lin from Macungie, PA, participated in IAP 2012 Teach for America.

Akansh Murthy from Bangalore, India, was awarded a Public Service Center IAP 2012 Fellowship.

Sarah Sprague from Marengo, IL, was awarded a Certificate of Engineering Leadership by the Gordon-MIT Engineering Leadership Program.

Eric Trac from Hercules, CA, received second prize in the Isabelle de Courtivron Prize. The prize is awarded for excellence in student writing on topics related to immigrant, diaspora, bicultural, bilingual, and/or mixed-race experiences. Trac also was named a Public Service Center Fall 2011-IAP 2012 Student Leader in Service and participated in IAP 2012 Teach for America.

Shu Zheng from Shanghai, China, was awarded an Emerson Music Fellowship.

The Department of Brain and Cognitive Sciences gave honorable mentions for Outstanding Academic Record to biology majors Hamsika Chandrasekar from Sugarland, TX, and Alissa Totman from Lynnfield, MA; and an honorable mention for Outstanding Research to Erica Pino from Jupiter, FL.

### ***Class of 2014***

Cynthia Chen from Forest Hills, NY, was awarded a Public Service Center IAP 2012 Fellowship.

Paige Finkelstein from Boca Raton, FL, won the Chemical Engineering Special Service Award.

Alvin Jeon from Jericho, NY, received the Gene Brown Prize for outstanding academic scholarship and demonstrated excellence as a teaching assistant in 7.02 Introduction to Experimental Biology and Communication from the MIT Department of Biology.

Laura McCulloch from New Canaan, CT, won first prize in the S. Klein Prize for Technical Writing.

Suan Tuang from Orlando, FL, was awarded by the chemistry department the Sophomore Achievement Award for outstanding performance as a sophomore in academics, research, and service to the department.

Edward Valle, a biology major from Los Angeles, CA, was awarded a MISTI Sun Fellowship.

Robert Williams, a biology major from El Paso, TX, was awarded a MISTI Sun Fellowship.

The Department of Brain and Cognitive Sciences gave honorable mentions for Outstanding Research to biology majors George Bailey from Edinburg, TX, and Danielle Cosio from Miami, FL.

### ***Class of 2015***

Halide Bey from Nicosia, Cyprus, took third prize in the Lufthansa Prize for excellence in German studies.

Vania Lee from Warner Robbins, GA, and Daniel Wang from Moreland Hills, OH, were awarded Emerson Music Scholarships (both in piano); and Divya Pillai from Oak Brook, IL, was received the award for voice.

Sixteen students spoke in the Undergraduate Research Symposium in January at the invitation of their research faculty mentors: Samuel Acquah, Ryan Alexander, Allison Alwan, Hamsika Chandrasekar, Frances Chen, Paul Jaffe, Melissa Ko, Kateryna Kozyrytska, Kenneth Lin, Victoria Lu, Akansh Murthy, Mariya Samoylova, Sabine Schneider, Lauren Sless, Sabina Sood, and Christina Welsh.

## Faculty

Finding outstanding people is the key to our success and we have taken great care to marshal our resources to make the department an exceptional incubator for young independent scientists. As a result, virtually all of our junior faculty are thriving.

### Appointments, Promotions and Other News

David Altshuler was appointed adjunct professor, effective July 1, 2012.

Tania Baker succeeded Chris Kaiser as department head on April 1, 2012.

Laurie Boyer was promoted to associate professor without tenure, effective July 1, 2012

Ian Cheeseman was promoted to associate professor without tenure, effective July 1, 2012

Alan Grossman was appointed associate department head of Biology and director of scientific operations for Building 68, effective July 1, 2012.

Dennis Kim was promoted to associate professor with tenure, effective July 1, 2012.

Chris Kaiser was appointed provost and chief academic officer, effective July 1, 2012.

Michael Laub was promoted to associate professor with tenure, effective July 1, 2012.

Jacqueline Lees was appointed associate department head of Biology, effective July 1, 2012.

Peter Reddien was promoted to associate professor with tenure and associate department head of Biology, effective July 1, 2012.

David Sabatini was promoted to professor, effective July 1, 2012.

Jeroen Saeij was promoted to associate professor without tenure, effective July 1, 2012. He also mentored 2011 Rhodes scholarship recipient Stephanie Lin.

H. Gobind Khorana, the Alfred P. Sloan professor of biology and chemistry, emeritus, passed away on November 9.

### Awards and Honors

Angelika Amon was appointed the Kathleen and Curtis (1963) Marble Professor of Cancer Research in September 2011.

David Bartel was awarded a MERIT award from the National Institute of General Medical Sciences in 2011.

Laurie Boyer was named to the Irwin and Helen Sizer Career Development chair in January 2012.

Iain Cheeseman was awarded the 2012 American Society for Cell Biology's Early Career Life Scientist Award.

Penny Chisholm received the Jim Tiedje Award from the International Society of Microbial Ecology, the 2012 Ruth Patrick Award from American Society of Limnology and Oceanography, and the 2011 Darbaker Prize from the Botanical Society of America.

Gerry Fink was elected to the International Scientific Advisory Board of the Weizmann Institute, Rehovot, Israel.

Mary Gehring was named a 2011 Pew Scholar in the Biomedical Sciences by The Pew Charitable Trusts. Mary was also named a Thomas D. and Virginia W. Cabot Career Development Professor in July 2011.

Lenny Guarente presented and was awarded the Charles H. Best Lectureship and Award by the University of Toronto in 2011.

Piyush Gupta received a Breast Cancer Alliance Young Investigator Grant in 2011 and the Smith Family Award for Excellence in Biomedical Research in 2011. He presented the Sosnovsky Distinguished Lectureship at the University of Wisconsin Milwaukee in 2011.

Michael Hemann was appointed the Eisen and Change Career Development Professorship in July 2011.

Nancy Hopkins was the 2012 recipient of the Margaret L. Kripke Legend Award for Promotion of Women in Cancer Medicine and Cancer Science presented by The University of Texas MD Anderson Cancer Center.

Barbara Imperiali was appointed an associate member of the Broad Institute in 2011.

Tyler Jacks was elected as a member of the American Academy of Arts and Sciences in 2012 and was appointed to the National Cancer Advisory Board, the White House.

Rudolf Jaenisch was honored by the International Society for Stem Cell Research with the 2012 McEwen Award for Innovation. The award is supported by the McEwen Centre for Regenerative Medicine in Toronto. The Centre honors "original thinking and groundbreaking research pertaining to stem cells or regenerative medicine that opens new avenues of exploration towards the understanding or treatment of human disease or affliction." He also received the J. Allyn Taylor International Prize in Medicine and the 2011 US Medal of Science from President Barack Obama.



Eric Lander is among the recipients of the 2012 Dan David Prize, a prestigious Israeli award for achievements having an outstanding scientific, technological, cultural, or social impact. Dan David Prizes are awarded in three categories: past, present, and future. This year, the prize's international board chose to award its "future" prize in the field of genome research, selecting individuals who have contributed to the scientific community's understanding of genomic structure and organization and those who have made significant discoveries in the field of synthetic genomics.

Douglas Lauffenburger received the Systems Biology Pioneer Award in 2011.

Susan Lindquist was elected as an associate member (US) of the European Molecular Biology Organization. She also was awarded the 2012 American Society for Cell Biology's highest honor: the E.B. White Medal.

J. Troy Littleton received a Distinguished Alumni Award from Baylor College of Medicine in 2011.

Adam Martin was named the Thomas D. and Virginia W. Cabot Career Development Professor in July 2011.

Elly Nedivi was appointed an associate member of the Broad Institute in 2011.

Terry Orr-Weaver received the 2011 Whitehead Institute Postdoctoral Mentor Award and the 2012 Distinguished Basic Science Lecturer, Dartmouth Medical School.

David Page appeared on Comedy Central's *Colbert Report* in March to defend the Y chromosome. He delivered the 2011 James V. Neel Lecture, University of Michigan; the 2012 Louis Levine–Gabriella de Beer Lecture in Genetics at City College of New York; and the Burdette Lecture at the Yale School of Medicine. He also received the March of Dimes Prize in Developmental Biology (shared with Patricia Jacobs).

Hidde Plough received the 2011 American Association of Immunologists Career Achievement Award.

Peter Reddien received the 2011 Mossman Award in Developmental Biology.

David Sabatini received the Earl and Thressa Stadtman Scholar Award from the American Society for Biochemistry and Molecular Biology. He received this inaugural award for "his work identifying the mTOR pathway, a major regulator of mammalian cell growth and a central component of pathways relating to metabolism and aging."

Philip Sharp is the 2012 president-elect for the American Association for the Advancement of Science; was elected in 2011 as a foreign fellow of the Royal Society, UK; and received an honorary Doctor of Science from the University of Minnesota.

Anthony Sinskey received an honorary doctorate from the Universiti Teknologi Malaysia in 2012. He was named a distinguished fellow of the International Islamic Academy for Life Sciences and Biotechnology in 2011. He also was the winner of the open mega-grant competition of the government of the Russian Federation in 2011.

Frank Solomon received the 2010–11 MIT School of Science Prize for Excellence in Graduate Teaching.

Matthew Vander Heiden was named the Howard S. and Linda B. Stern Career Development Professor in July 2011.

Bob Weinberg received the 2011 Science of Oncology Award from the American Society of Clinical Oncology. He also was awarded the American Academy for Cancer Research's 2012 Pezcoller Foundation–AACR International Award for Cancer Research for outstanding work in the fields of cell and molecular biology, and cancer genetics.

Matthew Wilson was elected to the American Academy of Arts and Sciences in 2012 and the American Association for the Advancement of Science in 2011.

Michael Yaffe was named the David H. Koch Professor in Science in November 2011.

Richard Young was elected to the National Academy of Sciences in 2012.

### Research Highlights

Angelika Amon and her group have discovered how yeast cells reverse aging. By turning on a gene in aged yeast cells, they were able to double the cells' usual lifespan. If the human cell lifespan is controlled in a similar way, it could offer a new approach to rejuvenating human cells or creating pluripotent stem cells. Amon is the senior author of a paper describing this work.

David Bartel and his group have identified conserved, long, intervening non-coding RNAs (lincRNAs) that play key roles during embryonic brain development in zebrafish. They also showed that the human versions of the lincRNAs can substitute for the zebrafish versions, which implies that the functions of these non-coding RNAs have been retained in humans as well as fish. Their findings were reported in the December 22, 2011, issue of *Cell*.

Penny Chisholm's group has discovered that viruses can bacteria into working for them, that is, the coevolution of guest and host lets a virus control its host's machinery. These findings suggest this is the first demonstration of a virus of any kind—even those heavily studied in biomedical research—that exploits this kind of regulatory machinery in a host cell. This work was published in the January 24, 2012, issue of *Current Biology*.

Gerry Fink and Hidde Ploegh have shown that protein unmasks pathogenic fungi to activate immune response. Their findings were published in the August 8, 2011, issue of *Proceedings of the National Academies of Sciences*. In that paper, they describe a mechanism by which immune cells can distinguish between pathogenic and non-pathogenic fungi and modulate the immune response accordingly.

Lenny Guarente and colleagues have now shown that sirtuins likely play a key role in the psychological response to dietary restriction. When sirtuins are elevated in the brain, as occurs when food intake is cut, mice become much more anxious. Furthermore, in two large genetic studies of humans, the team found that mutations that boost production of sirtuins are commonly associated with higher rates of anxiety and panic disorder. This work appeared online in *Cell* on December 8, 2011.

Piyush Gupta and Eric Lander's research collaborations suggest that cancer stem cells are made not born. The research appeared in the August 19, 2011, edition of *Cell*. The findings point to a much more decentralized society, with cancer cells able to interconvert between different types. These results have potential implications for the treatment of tumors; in particular, that attacking cancer stem cells alone may not be enough to fight cancer.

H. Robert Horvitz travelled with President Susan Hockfield to Davos, Switzerland, to participate in the annual meeting of the World Economic Forum in January 2012. The five-day meeting, which brought together leaders in business, politics, academia, and other areas, included a variety of discussions revolving around this year's theme: "The Great Transformation: Shaping New Models." An analysis of how human nature could improve society was the topic of discussion among faculty members.

Richard O. Hynes' group is investigating the question of platelets. The exact role played by platelets has been unclear, but findings shows that platelets give off chemical signals that induce tumor cells to become more invasive and plant themselves in new locations. The findings, published November 14, 2011, in *Cancer Cell*, may help researchers develop drugs that could prevent cancers from spreading if they are diagnosed before metastasis occurs.

Rudolph Jaenisch's group found a unique surface triples stem cell growth in culture. By irradiating typical polystyrene lab plates with ultraviolet waves, Whitehead Institute and MIT scientists have created a surface capable of tripling the number of human embryonic stem (ES) and induced pluripotent stem (iPS) cells that can be grown in culture by current methods. This research has relevance for diseases like Parkinson's, which likely will display only subtle phenotypes in the petri dish. The research was published online in the November 7, 2011, edition of *Proceedings of the National Academy of Sciences*.

Tomomi Kiyomitsu, a postdoctoral researcher in Iain Cheeseman's laboratory, solved a mitosis mystery: how chromosomes align perfectly in a dividing cell. He discovered when the spindle oscillates toward the cell's center, a partial halo of the protein dynein lines the cell cortex on the side farther away from the spindle. As the spindle swings to the left, dynein appears on the right, but when the spindle swings to the right, dynein vanishes and reappears on the left side. According to Kiyomitsu, the research shows that the spindle orientation "is critical for maintaining the balance between stem cells and mature cells during development." This work was published in the February 12, 2012, issue of *Nature Cell Biology*.

Susan Lindquist and her research team published findings in *Nature* showing that prions play a powerful role in the survival and evolution of wild yeast strains. The research team has shown that in yeast, prions awaken dormant stretches of genes that can help the yeast survive environmental stresses. Furthermore, those new traits can be passed on to offspring, contributing to evolution in an unexpected way. This work was reported in the February 15, 2012, edition of *Nature*. Professor Lindquist's team also reported that patients whose estrogen receptor (ER)-positive breast cancers have high levels of the ancient cellular survival factor heat shock factor 1 (HSF1) experience poor outcomes—including increased mortality. Her findings were published in the October 31, 2011, edition of the *Proceedings of the National Academy of Sciences*.

Harvey Lodish and his group have shown that long non-coding RNA prevents the death of maturing red blood cells. Their research shows that programmed cell death, or apoptosis, is very important, particularly in the hematopoietic (blood-forming) system, where inhibition of cell death leads to leukemias. Although researchers know a lot about the genes and proteins that regulate apoptosis, this is the first example of a non-coding RNA that plays a role in blood cells. This new lncRNA and its function are described in the online December 2011 edition of *Genes and Development*.

Elly Nedivi's research group and her collaborators coauthored a study that characterizes the distribution of inhibitory synapses across the brain's neurons and shows that they are divided into two populations: one on dendritic spines adjacent to an excitatory synapse, the other on the dendritic shaft. The results of this study provides evidence that experience-dependent plasticity in the brain is a highly orchestrated process, integrating changes in excitatory connectivity with the active elimination and formation of inhibitory synapses. This sheds new light on the importance of coordinating excitatory and inhibitory circuitry to help nurture long-term memory. This work appeared in the April 26, 2012, edition of *Neuron*.

Terry Orr-Weaver and her research group have found that brain cells increase their DNA content to preserve vital blood-brain barrier. As developing larval fruit fly brain grows by cell division, it instructs subperineurial glia (SPG) cells that form the blood-brain barrier to enlarge by creating multiple copies of their genomes in a process known as polyploidization. The researchers report their work in the January 2012 edition of *Genes and Development*. The thought is this may be the same developmental strategy that is used in other contexts, where an outer layer of cells is needed to maintain a seal, yet the organ also needs to grow during development.

David Page and his laboratory's latest research on the evolution of the human Y chromosome confirms that the Y, despite arguments to the contrary, has a long, healthy future ahead of it. This research represents the strongest evidence yet against the "rotting Y" theorists. Members of his lab have found evidence that strongly refutes the "rotting Y" theory by sequencing the Y chromosome of the rhesus macaque—an Old World monkey whose evolutionary path diverged from that of humans some 25 million years ago—and comparing it with the sequences of the human and chimpanzee Y chromosomes. The comparison, published in the February 22, 2012, online edition of *Nature*, reveals remarkable genetic stability on the rhesus and human Ys in the years since their evolutionary split.

Peter Reddien and his team reported on their development of a novel approach to identify and study the genes that control stem cell behavior in planarians. Intriguingly, at least one class of these genes has a counterpart in human embryonic stem cells. This revealed powerful new insights into the biology of stem cells—insights that may eventually help such cells deliver on a promising role in regenerative medicine. Their findings were reported in the March 1, 2012, online edition of *Cell Stem Cell*.

Using a new in vivo screening system, David Sabatini's team has identified a protein in the serine biosynthesis pathway that is essential in estrogen receptor (ER)-negative breast cancer—a notoriously difficult disease to treat associated with low five-year survival rates. The work was reported in the July 2011 edition of *Nature*. Sabatini's research on age-defying therapies include studying the drug rapamycin. Rapamycin is used for immunosuppression in organ transplants and mimics the longevity effects of calorie restriction and may tap into the same cellular pathways as calorie restriction. His research has discovered precisely how rapamycin is behaving at the cellular level. Results were published in the March 2012 edition of *Science*.

JoAnn Stubbe delivered the Killian Lecture on March 6: "Radicals: Your Life Is in Their Hands." Researchers are now harnessing Stubbe's discoveries to design therapies for cancer and other diseases that involve uncontrolled DNA replication. Stubbe is currently investigating the mechanisms behind drugs such as gemcitabine, a chemotherapeutic used to treat pancreatic cancer and other carcinomas. Gemcitabine acts to inhibit ribonucleotide reductase (RNR) activity, which in turn stops DNA replication and triggers tumor-cell death. Stubbe's research group is also exploring ways to reduce the activity of free radicals involved in RNR—a potential mechanism for RNR inhibition.

Susumu Tonegawa and his research team found that the means by which traces of memory are stored, engrams, have only been hypothetical, which means scientists did not have an idea of the actual, concrete means by which memories are stored in the brain. However, in a new study, MIT researchers used optogenetics (a combination of optical and genetic methods to control events) in cells of living tissue—essentially the manipulation of cells so they are sensitive and responsive to light—to show that memories are actually kept inside brain cells. Tonegawa was the lead author of the study reported online in the March 22, 2012, edition of *Nature*.

Matthew Vander Heiden and his research team and local collaborators have now developed a way to identify a particular subset of brain tumors, which may help doctors choose treatments and create new drugs that target the disease's underlying genetic mutation. Vander Heiden is part of the team that developed imaging technology to reveal whether brain tumors have the IDH mutation, which could help researchers monitor whether potential drugs are having the desired effect. The researchers described their technique in the January 11, 2012, online edition of *Science Translational Medicine*. Vander Heiden also coauthored a paper that helps explain how cancer cells get by on a starvation diet: tumor cells, deprived of glucose, alter their metabolism to use other sources of sustenance. The researchers found that when deprived of oxygen, cancer cells (and many other mammalian cells) can engage an alternate metabolic pathway that allows them to use glutamine, a plentiful amino acid, as the starting material for synthesizing fatty molecules known as lipids. These lipids are essential components of many cell structures, including cell membranes.

Graham Walker and his colleagues revealed the killing mechanism behind all three major classes of antibiotics: the drugs produce destructive molecules that fatally damage bacterial DNA through a long chain of cellular events. Penicillin and other antibiotics have revolutionized medicine, turning once-deadly diseases into easily treatable ailments. However, while antibiotics have been in use for more than 70 years, the exact mechanism by which they killed bacteria remained a mystery prior to the study's findings. The study is reported in the April 20, 2012, edition issue of *Science*.

Rick Young's laboratory has uncovered the critical role one enzyme, lysine-specific demethylase 1 (LSD1), plays as embryonic stem cells differentiate into other cell types. Their research is published online in the February 1, 2012, edition of *Nature*.

## New Directions

### Space

Construction was completed in the winter of 2011 on the first floor of Building 68 in space formerly occupied by the Bio Café. There is now a small conference room for [undergraduate seminars](#), an infant daycare facility managed by Technology Children's Center, and a scholar's lounge for use by the biology postdoctoral students. The lounge was featured in [Tech Talk](#) (2/10/12 edition).

Construction also was completed to retrofit a chemistry laboratory into biology space. This enabled Barbara Imperiali to relocate her operations to Building 68.

### Staff

Our staff is among our richest resource and makes important contributions. They are integral to the department's success and infrastructure. We hired five new staff this past year:

Elizabeth Fong transferred to the biology department with Barbara Imperiali in July and serves as an administrative assistant II. She divides her time between our supporting faculty and our central finance office.

Darlene McGurl returned to the biology department as an administrative assistant II in February. She previously served in this role from 1983 to 2005. More recently she served as a financial officer at the Koch Institute.

Ben Reed joined the Education Office in May as an academic administrative assistant. Ben worked previously as an administrative assistant at the Massachusetts Behavioral Health Partnership in Boston, and at Morgan Stanley in Chicago.

Karen Sadler transferred to the biology department in May to serve as our human resources administrator. She previously served as a human resources coordinator at the Koch Institute. She has extensive human resources generalist experience, holds a master's degree in human resources from Westminster University, and is certified as a senior professional in human resources and as a mediator in conflict resolution. She succeeds Erminia Piccinonno who transferred to the School of Humanities to seek a growth opportunity.

Magdalah "Maggie" Wesh transferred to the department in August and serves as a financial assistant II in our central finance office. She previously served in the MIT Energy Initiative where she managed a wide range of financial responsibilities.

### **Resource Development**

We have been working to clarify our priorities and develop new relationships in resource development. A small team of faculty leaders are working with Laurie Ledeen, director of Resource Development, to develop these relationships. While there are challenges, we've made progress toward raising the profile of the department both internally and externally, and on improving and increasing the department's stewardship of existing donors and the cultivating new ones.

Some of our achievements include launching a redesigned [website](#) in December, and producing the first edition of BIOLOG, the department's new biannual [newsletter](#) that has been distributed to donors, potential donors, and alumni.

Major donor activities in biology included September and December visits of Dr. Paul Schimmel, a \$2 million lifetime donor who made a new gift of \$30,000 to the department for its history project and has stated his intention to bequest \$10M from his estate to MIT.

**Tania A. Baker, PhD**  
**Department Head**  
**HHMI Investigator and Professor of Biology**