

## Dean, School of Science

The School of Science has an unmatched record of excellence in research and education. In addition to a wide variety of awards for distinguished research and service, the achievements of our faculty members have been recognized by 10 Nobel Prizes since 1990, and one faculty member has won the Abel Prize, the equivalent of a Nobel for mathematics. In the last *US News and World Report* survey of graduate schools, each of our six departments was ranked among the best in the nation. Our graduate students have gone on to win 16 Nobel Prizes. Our graduate and undergraduate alumni have built upon their superb education to become leaders of business, industry, and government.

With nearly 300 faculty members, 1,100 graduate students, and 900 undergraduate majors, the School is large enough to carry out research at the most exciting frontiers of science. Some members of our community study very fundamental questions: our physicists are working toward understanding the nature of dark matter and dark energy, which make up 95% of the content of our universe. In the Department of Brain and Cognitive Sciences (BCS), researchers are studying how the brain, a complex system of interconnected neurons, gives rise to the mind—that is, human consciousness and the ability to learn. Other faculty members study problems that have obvious practical implications, such as how global warming increases the intensity of hurricanes or how to make adult stem cells capable of generating any cells in the body, so that we could replace cells damaged by disease without using embryos.

Often the most profound and important questions require collaborations between groups with different expertise, sometimes in different departments or different schools. Researchers in the School of Science, do not allow such academic boundaries to prevent them from working together, and interdisciplinary work, especially with the School of Engineering, continues to increase. Excellent examples are the Koch Institute for Integrative Cancer Research, which combines scientific and engineering approaches to the detection and treatment of cancer, and the new graduate program in microbiology, which involves faculty members from many departments in Science and Engineering.

### Building and Strengthening a Diverse Community

One of the highest priorities of the School administration is to support our existing outstanding faculty and to recruit exceptionally talented young researchers and educators, especially underrepresented minorities and women, to our faculty. Individual departments have used a variety of strategies to recruit a more diverse faculty and student population, including travel grants for graduate students, the appointment of staff members tasked with diversity recruitment, and the creation of the Faculty Search Oversight Committee tasked with overseeing faculty search committees, and turning attention to retaining minority graduate students. The School has done particularly well with hiring new female faculty members. Of the nine faculty members hired this year, five are women: Professor Wendy Gilbert in the Department of Biology, Professors Yingxi Lin and Weifeng Xu in BCS, and Professors Jocelyn Monroe and Janet Conrad in the Department of Physics. Progress in hiring minority faculty members has been much less successful. We believe that we must start by increasing the fraction of graduate

students who are underrepresented minorities, and we have focused our efforts there. In particular, we have developed a program, in collaboration with the dean for graduate education and the departments, to guarantee support for minority graduate students throughout their time at MIT.

## Education

Unlike most leading schools of science, MIT puts great emphasis on hiring and promoting young faculty members. As evidence, six of our recent Nobel-winning faculty members came to MIT without tenure and did their most important research here. We believe that this emphasis is one reason why our faculty are deeply committed to undergraduate education. It is not uncommon for Nobel Prize winners and others among our best researchers to teach freshman subjects. The School is responsible for providing MIT undergraduates with a strong science base for studies in their major, and the School's faculty are dedicated to doing this very well. The School and its departments participate in and support a variety of programs designed to create more active, student-centered learning environments inside the classroom. The d'Arbeloff Interactive Mathematics Project and the Technology-Enabled Active Learning program for freshman physics both integrate technology into coursework, making learning more effective. The Undergraduate Research-Inspired Experimental Chemistry Alternatives curriculum integrates cutting-edge research with core chemistry concepts. The reports from individual departments provide more details about these programs.

The School of Science is deeply committed to graduate education, and we attract exceptional students to our graduate programs. Because of its growing importance and attractiveness to graduate students, making interdisciplinary research available is a priority. MIT will welcome its first class of graduate students to the microbiology graduate PhD program this fall, which will integrate courses and research opportunities from departments in both the School of Science and the School of Engineering. The program will give graduate students access to areas of expertise such as cell and molecular biology, pathology, immunology, environmental biology, oceanography, computational biology, synthetic biology, and chemical engineering. Moreover, the participation of microbiology PhD candidates in laboratories in these areas will create synergistic research opportunities, benefiting both students and the research projects in which they participate.

## Research

As always, School of Science faculty members have made significant contributions in research this year, achieving discoveries in the development of green energy resources, cancer treatment and detection, the structure and function of the brain and consciousness, and space research, among many others. The individual reports of the departments and other units will give more thorough accounts, but we provide a few highlights here.

Institute Professor and professor of physics and electrical engineering Mildred Dresselhaus worked with researchers at MIT and Boston College to improve the efficiency of a commonly used thermoelectric material, bismuth antimony telluride, by 40%. By rebuilding it in a composite of nanostructures in bulk form, they were able

to dramatically slow heat conduction without interfering with electrical conductivity. Because the new technology is inexpensive and environmentally friendly, it can be applied to improve the energy efficiency of a host of products.

In Michale Fee's laboratory at the McGovern Institute, researchers discovered immature and adult birdsong to be driven by two different pathways. One pathway, responsible for highly variable babbling in the learning phase, becomes masked by the mature motor pathway responsible for stereotyped song. If the latter pathway is disabled, the former remains functional and takes over. Fee speculates that these results may apply to other forms of exploratory behavior, not just in birds, but in humans as well.

Induced pluripotent stem (IPS) cells, normal adult cells that have been reprogrammed to behave like stem cells, were successfully integrated into rodent brains by researchers in the Rudolf Jaenisch laboratory, reducing symptoms of a neurodegenerative condition that suppresses dopamine function much like Parkinson's disease. Jaenisch lab researchers also refined the production of IPS cells, developing a method that introduces transformative genes in exactly the same place for all cells, eliminating much of the unpredictable variation of previous IPS cells.

With a team of researchers at MIT and New York University, Department of Chemistry professor Stephen Lippard discovered a vulnerability in anthrax bacteria: *Bacillus anthracis* was found to depend on the production of nitric oxide (NO) for defense against the immune system. The team followed up research by screening libraries of chemicals for compounds able to interfere with NO production in anthrax, with the eventual development of new antibiotics in mind.

John and Dorothy Wilson professor of biology and professor of geobiology Dianne Newman is studying how some kinds of anaerobic bacteria function in the human body by studying fossilized deposits of ancient anaerobic bacteria thought to exist billions of years ago. She has already identified a compound called phenazine in *Pseudomonas aeruginosa* (a species of bacteria found in lung infections and burn wounds) that enables its survival in the anaerobic environment of the wound, which could become a target for drugs to treat infections.

The Henry Dreyfus professor of energy and professor of chemistry Daniel Nocera, along with postgraduate researcher Matthew Kanan, developed a photosynthesis-inspired solar energy technology, using sunlight to split water into hydrogen and oxygen, which could then be recombined in a fuel cell. The process depends on developing a new catalyst for production of oxygen gas, consisting of cobalt, phosphate, and an electrode, which can be used with any energy source, such as a photovoltaic cell or wind turbine. The simplicity and low cost of the technology could advance solar technology toward the goal of making it a mainstream energy source.

Mathematics professor David Vogan participated on the Atlas team sponsored by the National Science Foundation and the American Institute of Mathematics, which successfully mapped out one of the most complicated structures in mathematics. The structure,  $E_8$ , is one of many Lie groups, which are used to study the symmetry of objects

and are indispensable to many fields of mathematics and theoretical physics. Though  $E_8$  was discovered in 1887, such a breakthrough was not thought possible and represents a major achievement in mathematics and in the large-scale computing that was necessary to complete the project. The project was commended by Congress on March 27, 2008, one week after it was unveiled at MIT.

Researchers in the Robert Weinberg lab have discovered that cancer cells actively recruit normal cells from local and distant sites to help the tumor thrive. Some breast cancer cells were found to recruit normal mesenchymal stem cells (MSCs) for the production of CCL5, a protein related to cell movement and found in elevated quantities at advanced stages of breast cancer; the presence of CCL5 alone was enough to increase the metastatic properties of cancer cells. Since MSCs and CCL5 could account for metastasis in a considerable proportion of breast cancer patients, CCL5 is a promising therapeutic target.

BCS professor Richard Wurtman announced promising results of clinical trials based on his research at the 2008 Alzheimer's Association International Conference on Alzheimer's Disease. Souvenaid®, a nutrient drink developed by the French food products company Danone, contains uridine monophosphate, choline, omega-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)—all precursors to components of cell membranes, including those of brain cells. Statistically significant improvement in delayed verbal memory tasks occurred for patients in a mild stage of the disease, and even better results were obtained in patients with very mild forms of Alzheimer's. The nutrient has a good safety profile and was well-tolerated by trial participants.

Head of the Department of Earth, Atmospheric and Planetary Sciences (EAPS), Maria Zuber, and postdoctoral researcher and team leader Jeffrey Andrews-Hanna contributed to the discovery of the largest deposit of frozen water in the inner solar system at the southern pole of Mars. Their research resolves uncertainty about whether the region was composed of ice, dust, or both. The team will perform a similar study on the northern polar cap. Zuber and Andrews-Hanna also participated in a study that provided strong evidence that the Borealis basin on Mars is the largest impact scar in the solar system. The origin of the Borealis basin has been controversial since its images were returned from spacecraft in the 1970s; the other theory argues that internal processes in the planet's molten substrate formed the basin. The impact theory fell into disfavor because the basin was elliptical, rather than having the circular shape expected for impact basins. Researchers were able to reconstruct the original shape of the basin before volcanic activity changed it, which turned out to be one very characteristic of large impacts.

## Space

MIT broke ground on March 7, 2008, for the building destined to house the new David H. Koch Institute for Integrative Cancer Research. Slated to open in December 2010, the building is designed to encourage close interaction among researchers in biology and engineering, in terms of both its floor plan and its central location at Ames and Main streets. Its 180,000 square feet of state-of-the-art laboratory and workspace will be equipped with the most sophisticated research tools available, including facilities for bioinformatics and computing, genomics, proteomics and flow cytometry, large-scale facilities for genetic engineering and testing, advanced imaging equipment, and nanomaterials characterization labs.

The Green Center for Physics, part of the larger Physics, Department of Materials Science and Engineering, Spectroscopy, and Infrastructure Project, was opened officially in October 2007. Named in honor of Cecil (EE 1923) and Ida Green, the center was designed with the goal of fostering new research collaborations. The center occupies the fourth floor of Building 6; the first (atrium), second, third, and fourth floors of Building 6C (a new infill structure replacing Building 6A); and the third floors of Buildings 4, 6, and 8, where spaces have been significantly improved. The Physics Department's administrative, academic, and some community functions are now in one location, along with educational labs and a reading room. The new center has also brought together MIT's theoretical physicists, housing the Condensed Matter Theory Group and the Virgil Elings Center for Theoretical Physics.

## Events

### Celebrating MIT

In May 2007, Susumu Tonegawa, founding director of the Picower Institute for Learning and Memory, was honored by a dinner in celebration of his innovative career and essential role in the formation of the institute. The event was hosted by Dean Marc Kastner at the Hotel Marlowe in Cambridge. More than 50 members of the national scientific community attended, in addition to Barbara and Jeffry Picower, whose visionary gift established the institute. The dinner coincided with the Picower Symposium, "Genes, Circuits, and Behavior," in timely consideration of recently developed genetic and optical circuit intervention technologies bridging the gap between molecular and cellular neurobiology and systems and behavioral neuroscience. The symposium was open to all students and scientists in the Greater Boston area and brought together internationally renowned neuroscientists who are actively involved in research on these topics.

In his April 2008 talk, entitled "Reflections on an MIT Education," Neil Pappalardo recounted the rise of Meditech, one of the earliest software companies and a leading supplier of information systems software for hospitals in the United States, Canada, and the United Kingdom; he explained how the company emerged from his MIT senior thesis. The purpose of the talk, cosponsored with the School of Engineering, was to offer a useful model for students and postdocs thinking about their careers. Pappalardo wove his account with meditations about what he had learned at MIT, advising graduates to continue to develop the creativity and capacity for discovery encouraged at MIT and to be confident enough in their abilities to remain strong in the face of the skepticism that new ideas often meet in the business world.

### Celebrating Diversity

Lisa Steiner, a professor of immunology and the first woman faculty member to join the Department of Biology at MIT in 1967, was honored at a special luncheon by her friends and colleagues at the MIT Faculty Club on May 22. For many years, Steiner was a role model and inspiration to the few female graduate and undergraduate students in the Department of Biology. The department has come a long way since she was hired and women now account for more than 28% of the faculty, 50% of graduate students, and more than 65% of undergraduate biology majors. At the luncheon in her honor, her

MIT colleagues took turns paying tribute to her science, her strength, her character, her integrity, and her kindness.

MIT's first Women in Mathematics conference, held April 12–13, 2008, was organized to celebrate women's successes in the discipline. The conference, attended by more than 150 women, was organized by Professors Gigliola Staffilani and Katrin Wehrheim at the suggestion of MIT alumna Susan Landau. Seven mathematicians, from MIT and other institutions around the country, spoke about their research in pure and applied mathematics. Two panels convened to discuss the lives of women in mathematics at different stages of their careers, the first offering advice to young mathematicians entering the field and the second presenting the perspective of women who graduated from the 1960s to the early 1980s. Conference organizers hope to increase the number of women in academic careers in math by showing strong female math students other women who have succeeded in the field.

### **School of Science Breakfast Series**

The School of Science commenced its Breakfast Series on December 12, 2007. Based on the successful Physics Breakfasts, the series is intended to introduce MIT friends and alumni to basic science research conducted by the faculty of the School. At the inaugural breakfast, professor of atmospheric science in EAPS, Kerry A. Emanuel, shared his research on the links between hurricanes and global warming, including his 2005 results linking an increasingly warm climate to a near-doubling of hurricane intensity over the past 30 years. Rebecca Saxe, assistant professor of cognition in BCS, was next in the series, giving a lecture entitled, "Uniquely Human Social Cognition: How the Brain Thinks about the Mind" on February 22, 2008. Saxe presented her recent groundbreaking research on the uniquely human ability to interpret others' thoughts. She identified the right temporo-parietal junction as specialized for thinking about other people's thoughts by using functional magnetic resonance imaging to measure blood flow to parts of the brain triggered by cognitive processes. On April 1, 2008, Mathematics Department Head Michael Sipser detailed one of the most famously unsolved problems in mathematics, the  $P$  versus  $NP$  problem, and, at the final School of Science Breakfast for the year in May, Professor Daniel G. Nocera announced that MIT was patenting his new technology for separating water into hydrogen and oxygen that very same week. The breakfasts will continue next year, beginning with talks by Cecil and Ida Green professor of earth and planetary sciences Robert van der Hilst and Novartis professor of biology Leonard P. Guarente. The success of the Breakfast Series has encouraged the School of Science to take it on the road this coming academic year, with plans being made for lectures to MIT friends and alumni in Palo Alto, Los Angeles, Chicago, and Greenwich, CT.

### **Communication**

The School is working to enhance communications both inside and outside the Institute. Last July, the School of Science launched its new website, which serves as a central source for information and resources for prospective and current students, alumni, staff, and faculty. This summer saw the creation of a newsletter for friends and alumni of the School, which will be launched early this fall.

## Awards and Honors

### Faculty Awards and Honors

Every year, academic and professional organizations honor numerous School of Science faculty for their innovative research as well as their service to the community. The individual reports from the School's departments, labs, and centers will document many of these awards. Several notable awards deserve additional mention:

- Ann M. Graybiel, in BCS, received the NARSAD Distinguished Investigator Award in 2008 and will use the \$100,000 grant to advance her study of a part of the brain that is associated with obsessive-compulsive disorder and addiction.
- George Lusztig, a professor in the Department of Mathematics was awarded the Leroy P. Steele Prize for Lifetime Achievement, one of the highest distinctions in mathematics. His work "entirely reshaped representation theory" and, in the process, provoked wide-reaching changes in the field of mathematics.
- Alexander Rich, a professor in the Department of Biology, was awarded the prestigious Welch Award in Chemistry in 2008, because "his numerous contributions have provided such important fundamental insights that virtually every important area of biochemistry or molecular biology today has Dr. Rich's fingerprints on it."
- JoAnne Stubbe, professor in the departments of Chemistry and Biology, was awarded the 2008 National Academy of Sciences (NAS) Award in Chemical Sciences for her work on ribonucleotide reductases. NAS described the work as "a compelling demonstration of the power of chemical investigations to solve problems in biology."
- Professor of biology Robert A. Weinberg was the first recipient of the Georg and Eva Klein Award in 2008 in honor of his pioneering discoveries in basal tumor biology.
- Six professors were elected this year to NAS: Edward A. Boyle, EAPS; Stephen L. Buchwald, Department of Chemistry; Marc A. Kastner, Department of Physics; Frank T. Leighton, Department of Mathematics; Timothy M. Swager, Department of Chemistry; and Jack L. Wisdom, EAPS.
- In 2008, five School of Science faculty members were elected fellows of the American Academy of Arts and Sciences: Tobias Colding, Department of Mathematics; Christopher C. Cummins, Department of Chemistry; Alan D. Grossman, Department of Biology; Timothy L. Grove, EAPS; and Marc A. Kastner, Department of Physics.
- Richard R. Schrock, Frederick G. Keyes professor of chemistry, and Roger E. Summons, professor of geobiology, were elected fellows of Great Britain's Royal Society.
- Roger E. Summons, a professor in EAPS, received the 2007 Humboldt Research Award "in recognition of lifetime achievements in research."

- Physics professor Alexander van Oudenaarden was also named a Guggenheim Fellow in 2008 and will use the fellowship to study stochastic gene expression in development.
- Professors of biology Dianne K. Newman and David M. Sabatini and professor of chemistry and biology Catherine Drennan were named Howard Hughes Medical Institute Investigators in 2008.
- Professors Emery Brown and Susumu Tonegawa of BCS, Daniel Nocera of the Department of Chemistry, and Maria T. Zuber of EAPS were named fellows of the American Association for the Advancement of Science.

### **School of Science Rewards and Recognition**

The School of Science Rewards and Recognition Program continues to recognize the many dedicated and hard-working people within our departments, labs, and centers. The Infinite Mile Award recognizes employees in the School of Science for their dedication to the School and their willingness to devote the exceptional effort required to accomplish their jobs. The Dean's Educational & Student Advising Program Award rewards employees in the School of Science for their dedication to their educational programs and student advising. During the 2008 academic year, a total of 11 awards were given. The School also began offering financial grants to units to allow them to recognize staff contributions at the local level. In addition, the School continues to offer Spot Awards, which recognize employees "on the spot" for doing something beyond their normal duties.

### **Personnel**

#### **Appointments and Promotions**

In 2008, assistant professor appointments were made to Wendy Gilbert in the Department of Biology, Yingxi Lin and Weifeng Xu in BCS, Taylor Perron in EAPS, Lie Wang in the Department of Mathematics, and Jocelyn Monroe in the Department of Physics.

Professors Bjorn Poonen and Scott Sheffield in the Department of Mathematics and professor of physics Janet Conrad were given full professor appointments at MIT.

In the previous academic year assistant professor appointments were made to Laurie Boyer, Iain Cheeseman, and Paul Chang in the Department of Biology; Tanja Bosak, Linda Elkins-Tanton, Oliver Jagoutz, Alison Malcolm, Paul O'Gorman, and Shuhei Ono in EAPS; Jonathan Kelner and Abhinav Kumar in the Department of Mathematics; and Nuh Gedik and Pablo Jarillo-Herrero in the Department of Physics.

Professor of biology David Sabatini and professor of physics Young S. Lee were granted tenure.

The following were promoted to associate professor without tenure: Aude Oliva and Christopher Moore in BCS; Mohammad Movassaghi, Sarah O'Connor, and Troy Van Voorhis in the Department of Chemistry; Stephane Rondenay and Sang-Heon Dan

Shim in EAPS; and Eric Hudson, Scott Hughes, Hong Liu, and Gabriella Sciolla in the Department of Physics.

Professor of chemistry and biology Catherine Drennan, and professor of physics Alexander van Oudenaarden were promoted to full professor.

Edward H. Adelson of BCS was appointed to a five-year John and Dorothy Wilson professorship. Michael Hemann of the Department of Biology obtained the three-year Latham Family career development professorship. Michael T. Laub of the Department of Biology was named a Whitehead career development professor for a three-year term. Biology professor Dianne K. Newman was appointed to a five-year John and Dorothy Wilson professorship. Jonas Peters of Chemistry was named the W.M. Keck professor of energy for a five-year term. Physics professor Gabriella Sciolla will hold the Cecil and Ida Green career development professorship for a three-year term. Gigliola Staffilani of the Department of Mathematics is the next holder of the five-year Abby Rockefeller Mauze professorship. Katrin Wehrheim of the Department of Mathematics was appointed the Rockwell International career development professorship for a three-year term.

Maria T. Zuber of EAPS and Mriganka Sur of BCS were reappointed as department heads of their respective departments for five more years. Jacqueline Hewitt, director of the Kavli Institute for Astrophysics and Space Research; Mark Bear, director of the Picower Institute for Learning and Memory; and Richard Milner, director of the Laboratory for Nuclear Science were all reappointed to their posts.

### **Tenure Track Faculty Lunch Program**

The School launched a new program with the goal of introducing junior faculty in different departments to one another and providing a forum for discussion of important issues. At these lunchtime meetings, relevant speakers discuss key topics of particular interest to junior faculty, including effective teaching strategies, graduate student advising and mentoring, research, and research presentations. Future subjects will include leadership skills for science faculty.

### **School of Science Learn@Lunch Series**

To provide administrative staff the support they need to do their jobs effectively, the School of Science holds a monthly lunch series for staff members on informational topics, training, and research highlights. Topics for the past academic year included retirement benefits and planning, tuition assistance, stress management, human resources initiatives, and salary compensation. The lunches were well attended and provoked very positive responses from School staff.

**Marc A. Kastner**

**Dean**

**Donner Professor of Physics**

*More information about the School of Science can be found at <http://web.mit.edu/science/>.*