The Briefing Book is researched and written by a variety of MIT faculty and staff, in particular the members of the Office of the Provost’s Institutional Research group, Industrial Liaison Program, Office of the President, Office of Sponsored Programs, Student Financial Services, and the MIT Washington Office.

Executive Editors
Maria T. Zuber, Vice President for Research
mtz@mit.edu
William B. Bonvillian, Director, MIT Washington Office
bonvill@mit.edu

Editors
Shirley Wong
shirleywong@mit.edu
Lydia Snover, to whom all questions should be directed
lsnover@mit.edu
### MIT Senior Leadership

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<td>Provost</td>
<td>Chris A. Kaiser</td>
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<td>Chancellor</td>
<td>W. Eric L. Grimson</td>
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<td>Executive Vice President and Treasurer</td>
<td>Israel Ruiz</td>
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<td>Vice President for Research</td>
<td>Maria T. Zuber</td>
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<td>Vice President</td>
<td>Claude R. Canizares</td>
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<td>Vice President and Secretary of the Corporation</td>
<td>Kirk D. Kolenbrander</td>
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<td>Vice President for Resource Development</td>
<td>Jeffrey L. Newton</td>
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<td>Vice President and General Counsel</td>
<td>R. Gregory Morgan</td>
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<td>Vice President for Human Resources</td>
<td>Alison Alden</td>
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<td>Michael W. Howard</td>
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<td>Director, Lincoln Laboratory</td>
<td>Eric D. Evans</td>
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<td>Dean, School of Architecture and Planning</td>
<td>Adèle Naudé Santos</td>
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<td>Dean, School of Engineering</td>
<td>Ian A. Waitz</td>
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<td>Dean, School of Humanities, Arts, and Social Sciences</td>
<td>Deborah K. Fitzgerald</td>
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<td>Director of Libraries</td>
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<td>Christine Ortiz</td>
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<td>Chris Colombo</td>
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MIT Washington Office
The MIT Washington Office was established in 1991 to provide a presence in the nation’s capital for MIT, one of the country’s premier academic institutions with a long history of contributing to U.S. leadership in science and technology. A part of the MIT President’s Office, the Washington Office works closely with the Institute’s senior leaders to develop and advance policy positions on R&D and education issues. The office also supports major MIT initiatives in areas where national policy is being developed, currently including advanced manufacturing; the convergence of the life, engineering and physical sciences; energy and the environment; and innovative educational technologies. MIT students work with the Washington Office to gain hands-on experience in the science and technology policy-making process.

Staff
Director
William B. Bonvillian

Assistant Director
Philip H. Lippel

Senior Policy Advisor
Amanda J. Arnold

Address
MIT Washington Office
820 First Street, NE, Suite 610
Washington, DC 20002

Telephone Number
202.789.1828

Fax Number
202.789.1830

Website
http://dc.mit.edu/
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# Section 1

## Facts and History

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Facts and History

The Massachusetts Institute of Technology is one of the world’s preeminent research universities, dedicated to advancing knowledge and educating students in science, technology, and other areas of scholarship that will best serve the nation and the world. It is known for rigorous academic programs, cutting-edge research, a diverse campus community, and its long-standing commitment to working with the public and private sectors to bring new knowledge to bear on the world’s great challenges.

William Barton Rogers, the Institute’s founding president, believed that education should be both broad and useful, enabling students to participate in “the humane culture of the community” and to discover and apply knowledge for the benefit of society. His emphasis on “learning by doing,” on combining liberal and professional education, and on the value of useful knowledge continues to be at the heart of MIT’s educational mission.

MIT’s commitment to innovation has led to a host of scientific breakthroughs and technological advances. Achievements of the Institute’s faculty and graduates have included the first chemical synthesis of penicillin and vitamin A, the development of inertial guidance systems, modern technologies for artificial limbs, and the magnetic core memory that enabled the development of digital computers. Exciting areas of research and education today include neuroscience and the study of the brain and mind, bioengineering, energy, the environment and sustainable development, information sciences and technology, new media, financial technology, and entrepreneurship.

University research is one of the mainsprings of growth in an economy that is increasingly defined by technology. A study released in February 2009 by the Kauffman Foundation estimated that MIT graduates had founded 25,800 active companies. These firms employed about 3.3 million people, and generated annual world sales of $2 trillion, or the equivalent of the eleventh-largest economy in the world.

MIT has forged educational and research collaborations with universities, governments, and companies throughout the world, and draws its faculty and students from every corner of the globe. The result is a vigorous mix of people, ideas, and programs dedicated to enhancing the world’s well-being.

Fields of Study

MIT supports a large variety of fields of study, from science and engineering to the arts. MIT’s five academic schools are organized into departments and other degree-granting programs. In addition, several programs, laboratories, and centers cross traditional boundaries and encourage creative thought and research.

School of Architecture and Planning
Architecture
Media Arts and Sciences
Urban Studies and Planning
Center for Real Estate

School of Engineering
Aeronautics and Astronautics
Biological Engineering
Chemical Engineering
Civil and Environmental Engineering
Electrical Engineering and Computer Science
Engineering Systems
Health Sciences and Technology
Materials Science and Engineering
Mechanical Engineering
Nuclear Science and Engineering
Digital Learning
The Office of Digital Learning (ODL) is committed to helping the MIT community transform education on campus and worldwide through the opportunities afforded by emerging learning technologies. Through MIT OpenCourseWare, the Office of Educational Innovation and Technology, and MITx—in collaboration with edX—ODL helps faculty to experiment with and implement technology-supported pedagogies, expands global access to MIT educational materials, and furthers the understanding of best practices in emerging digital and scalable learning activities.

MIT OpenCourseWare is MIT’s long-standing effort to share the core academic materials—including syllabi, lecture notes, assignments, and exams—from the entire MIT curriculum freely and openly on the Web to support formal and informal education worldwide.

The Office of Educational Innovation and Technology partners with faculty, staff and students in the exploration, development, and dissemination of innovative uses of technology for teaching and learning in the classroom and online.

A constituent office of the Office of Digital Learning, MITx works with MIT faculty to employ emerging digital scalable learning pedagogies and technologies both in the MIT residential courses and through courses offered globally on the edX platform.

A not-for-profit enterprise of its founding partners Harvard University and the Massachusetts Institute of Technology, edX is focused on transforming online and on-campus learning through ground-breaking methodologies, game-like experiences, and cutting-edge research on an open source platform. The edX platform hosts courses created by MITx for global audiences.

http://odl.mit.edu
Research Laboratories, Centers, and Programs

In addition to teaching and conducting research within their departments, faculty, students, and staff work in laboratories, centers, and programs.

Some of these include:

- Center for Advanced Urbanism
- Center for Archaeological Materials
- Center for Biomedical Engineering
- Center for Civic Media
- Center for Collective Intelligence
- Center for Computational Engineering
- Center for Computational Research in Economics and Management Science
- Center for Energy and Environmental Policy Research
- Center for Environmental Health Sciences
- Center for Global Change Science
- Center for Gynepathology Research
- Center for International Studies
- Center for Materials Science and Engineering
- Center for Real Estate
- Center for Transportation and Logistics
- Computer Science and Artificial Intelligence Laboratory
- Deshpande Center for Technological Innovation
- Division of Comparative Medicine
- Francis Bitter Magnet Laboratory
- Haystack Observatory
- Institute for Medical Engineering and Science
- Institute for Soldier Nanotechnologies
- Institute for Work and Employment Research
- Joint Program on the Science and Policy of Global Change
- Knight Science Journalism Program
- David H. Koch Institute for Integrative Cancer Research
- Laboratory for Financial Engineering
- Laboratory for Information and Decision Systems
- Laboratory for Manufacturing and Productivity
- Laboratory for Nuclear Science
- Lean Advancement Initiative
- Legatum Center for Development and Entrepreneurship
- Lincoln Laboratory
- Martin Trust Center for MIT Entrepreneurship
- Materials Processing Center
- McGovern Institute for Brain Research
- Media Laboratory
- Microsystems Technology Laboratories
- MIT Catalyst Clinical Research Center
- MIT Center for Art, Science, and Technology
- MIT Center for Digital Business
- MIT Energy Initiative
- MIT Kavli Institute for Astrophysics and Space Research
- MIT Portugal Program
- MIT Professional Education
- MIT Program in Art, Culture and Technology
- MIT Sea Grant College Program
- Nuclear Reactor Laboratory
- Operations Research Center
- Picower Institute for Learning and Memory
- Research Laboratory of Electronics
- Simons Center for the Social Brain
- Singapore-MIT Alliance for Research and Technology
- Sociotechnical Systems Research Center

http://web.mit.edu/research/
Academic and Research Affiliations

Collaborative Partnership

**edX**
A not-for-profit enterprise of its founding partners Harvard University and the Massachusetts Institute of Technology, edX is focused on transforming online and on-campus learning through groundbreaking methodologies, game-like experiences, and cutting-edge research on an open source platform. See pages 9 and 91 for more information.

**Idaho National Laboratory**
Under the purview of the U.S. Department of Energy, the Idaho National Laboratory includes the National University Consortium (NUC)—five leading research universities from around the nation whose nuclear research and engineering expertise are of critical importance to the future of the nation’s nuclear industry. MIT leads the NUC team in support of nuclear research and related education programs. The NUC consists of MIT, Oregon State University, North Carolina State University, Ohio State University, and University of New Mexico.

https://inlportal.inl.gov/portal/server.pt/community/home

**Magellan Project**
The Magellan Project is a five-university partnership that constructed and now operates two 6.5 meter optical telescopes at the Las Campanas Observatory in Chile. The telescopes allow researchers to observe planets orbiting stars in solar systems beyond our own and to explore the first galaxies that formed near the edge of the observable universe. Collaborating with MIT on the Magellan Project are Carnegie Institute of Washington, Harvard University, University of Arizona, and University of Michigan.

**Massachusetts Green High Performance Computing Center**
The Massachusetts Green High Performance Computing Center (MGHPCC) is a collaboration of five of the state’s most research-intensive universities—MIT, University of Massachusetts, Boston University, Northeastern University, and Harvard University—the Commonwealth of Massachusetts, CISCO, and EMC. The MGHPCC, which opened in November 2012, is a datacenter dedicated to providing the growing research computing capacity needed to support breakthroughs in science.

http://www.mghpcc.org/

**MIT and Masdar Institute Cooperative Program**
In 2006, MIT began collaborating with the government of Abu Dhabi to establish a graduate research university focused on alternative energy, sustainability, and advanced technology. The MIT and Masdar Institute Cooperative Program supports Abu Dhabi’s goal of developing human capital for a diversified knowledge-based economy. See page 90 for more information.

**Northeast Radio Observatory Corporation**
The Northeast Radio Observatory Corporation (NEROC) is a nonprofit consortium of educational and research institutions that was formed in 1967 to plan an advanced radio and radar research facility in the Northeast. NEROC presently consists of nine educational and research institutions, these are MIT, Boston University, Brandeis University, Dartmouth College, Harvard University, Harvard-Smithsonian Center for Astrophysics, University of Massachusetts, University of New Hampshire, and Wellesley College.

http://www.haystack.mit.edu/hay/neroc.html

**Singapore-MIT Alliance for Research and Technology Centre**
The Singapore-MIT Alliance for Research and Technology (SMART) Centre is a major research enterprise established by MIT in partnership with the National Research Foundation of Singapore. The SMART Centre serves as an intellectual hub for research interactions between MIT and Singapore at the frontiers of science and technology. See page 88 for more information about SMART.

http://smart.mit.edu/
Academic and Research Affiliations (continued)

**MIT Skoltech Initiative**
The MIT Skoltech Initiative is a collaboration between the Skolkovo Foundation, the Skolkovo Institute of Science and Technology (Skoltech), and MIT to develop a new graduate research university. The new institution aims to break ground in bringing together Russian, U.S., and global research and technology, and in integrating research, teaching, innovation, and entrepreneurship. See page 88 for more information.

**Synthetic Biology Engineering Research Center**
The Synthetic Biology Engineering Research Center (SynBERC) is a multi-institution research effort to lay the foundation for the emerging field of synthetic biology. In addition to MIT, participating universities are University of California at Berkeley, University of California at San Francisco, Harvard University, Stanford University, and Prairie View A&M University. SynBERC’s foundational research will be motivated by pressing biotechnology applications. SynBERC work will also examine the ethical, economic, and biosecurity implications of synthetic biology and assess the effects of intellectual property and security regimes on the development of the field.

http://synberc.org/

**Major Collaborator**

**Broad Institute**
The Broad Institute seeks to transform medicine by empowering creative and energetic scientists of all disciplines from across the MIT, Harvard, and the Harvard-affiliated hospital communities to work together to address even the most difficult challenges in biomedical research. See page 62 for more information.

http://www.broadinstitute.org/

**Charles Stark Draper Laboratory**
Founded as MIT’s Instrumentation Laboratory, Draper Laboratory separated from MIT in 1973 to become an independent not-for-profit research and educational organization. MIT and Draper Laboratory still collaborate in areas such as guidance, navigation and control, complex reliable systems, autonomous systems, information and decision systems, and biomedical and chemical systems.

http://www.draper.com/

**Howard Hughes Medical Institute**
Howard Hughes Medical Institute (HHMI) is a scientific and philanthropic organization that conducts biomedical research in collaboration with universities, academic medical centers, hospitals, and other research institutions throughout the country. Sixteen HHMI investigators hold faculty appointments.

http://www.hhmi.org/

**Ragon Institute**
The Phillip T. and Susan M. Ragon Institute was established at MIT, Massachusetts General Hospital, and Harvard in February 2009. The Ragon Institute brings scientists and clinicians together with engineers using the latest technologies in an interdisciplinary effort to better understand how the body fights infections and ultimately to apply that understanding against a wide range of infectious diseases and cancers. The initial focus of the institute is the need for an effective vaccine against AIDS.

**Whitehead Institute for Biomedical Research**
The Whitehead Institute is a nonprofit, independent research institution whose research excellence is nurtured by the collaborative spirit of its faculty and the creativity and dedication of its graduate students and postdoctoral scientists. Whitehead’s primary focus is basic science, with an emphasis on molecular and cell biology, genetics and genomics, and developmental biology. Whitehead is affiliated with MIT through its members, who hold faculty positions at MIT. A small number of junior investigators also hold positions at Whitehead Institute as part of the Whitehead Fellows program.

http://wi.mit.edu/

**Other Affiliation**

**MIT-Woods Hole Oceanographic Institution Joint Program in Oceanography and Applied Ocean Science and Engineering**
The Woods Hole Oceanographic Institution (WHOI) is the largest independent oceanographic institution in the world. MIT and WHOI offer joint doctoral degrees in oceanography and doctoral, professional, and master’s degrees in oceanographic engineering.
Naval Construction and Engineering
The graduate program in Naval Construction and Engineering (Course 2N) is intended for active duty officers in the U.S. Navy, U.S. Coast Guard, and foreign navies who have been designated for specialization in the design, construction, and repair of naval ships. The curriculum prepares Navy, Coast Guard, and foreign officers for careers in ship design and construction and is sponsored by Commander, Naval Sea Systems Command. Besides providing the officers a comprehensive education in naval engineering, the program emphasizes their future roles as advocates for innovation in ship design and acquisition.

http://web.mit.edu/2n/

Reserve Officer Training Corps Programs
Military training has existed at MIT since students first arrived in 1865. In 1917, MIT established the nation’s first Army Reserve Officer Training Corps (ROTC) unit. Today, Air Force, Army, and Naval ROTC units are based at MIT. These programs enable students to become commissioned military officers upon graduation. More than 12,000 officers have been commissioned from MIT, and more than 150 have achieved the rank of general or admiral.

https://due.mit.edu/rotc/rotc-programs

Study at Other Institutions
MIT has cross-registration arrangements with several area schools. At the undergraduate level, students may cross-register at Harvard University, Wellesley College, Massachusetts College of Art and Design, and the School of the Museum of Fine Arts. At the graduate level, qualified students may enroll in courses at Harvard University, Wellesley College, Boston University, Brandeis University, and Tufts University. International study opportunities including the Cambridge-MIT Exchange, departmental exchanges, and the MIT-Madrid Program are described on page 93.

Education Highlights
MIT has long maintained that professional competence is best fostered by coupling teaching with research and by focusing education on practical problems. This hands-on approach has made MIT a consistent leader in outside surveys of the nation’s best colleges. MIT was the first university in the country to offer curriculums in architecture (1865), electrical engineering (1882), sanitary engineering (1889), naval architecture and marine engineering (1895), aeronautical engineering (1914), meteorology (1928), nuclear physics (1935), and artificial intelligence (1960s). More than 4,000 MIT graduates are professors at colleges and universities around the world. MIT faculty have written some of the best-selling textbooks of all time, such as Economics by Paul A. Samuelson and Calculus and Analytic Geometry by George Thomas. The following are some notable MIT teaching milestones since 1969, when humans, including MIT alumnus Buzz Aldrin, first landed on the moon.

1969 MIT launches the Undergraduate Research Opportunities Program (UROP), the first of its kind. The program, which enables undergraduates to work directly with faculty on professional research, subsequently is copied in universities throughout the world. About 2,400 MIT students participate in UROP annually.

1970 The Harvard-MIT Program in Health Sciences and Technology is established to focus advances in science and technology on human health and to train physicians with a strong base in engineering and science.

1971 MIT holds its first Independent Activities Period (IAP), a January program that emphasizes creativity and flexibility in teaching and learning.

1977 MIT organizes the Program in Science, Technology, and Society to explore and teach courses on the social context and consequences of science and technology—one of the first programs of its kind in the U.S.
1981 MIT launches Project Athena, a $70 million program to explore the use of computers in education. Digital Equipment Corporation and IBM each contribute $25 million in computer equipment.

1981 The MIT Sloan School of Management launches its Management of Technology program, the world’s first master’s program to focus on the strategic management of technology and innovation.

1983–1990 MIT language and computer science faculty join in the Athena Language Learning Project to develop interactive videos that immerse students in the language and character of other cultures. The work pioneers a new generation of language learning tools.

1984 MIT establishes the Media Laboratory, bringing together pioneering educational programs in computer music, film, graphics, holography, lasers, and other media technologies.

1991 MIT establishes the MacVicar Faculty Fellows Program, named in honor of the late Margaret A. MacVicar, to recognize outstanding contributions to teaching. MacVicar, a professor of physics, had conceived of, designed, and launched UROP (see 1969, above).

1992 MIT launches the Laboratory for Advanced Technology in the Humanities to extend its pioneering work in computer- and video-assisted language learning to other disciplines. Its first venture was a text and performance multimedia archive for studies of Shakespeare’s plays.

1993 In recognition of the increasing importance of molecular and cell biology, MIT becomes the first college in the nation to add biology to its undergraduate requirement.

1995 MIT’s Political Science Department establishes the Washington Summer Internship Program to provide undergraduates the opportunity to apply their scientific and technical training to public policy issues.

1998 MIT teams up with Singapore’s two leading research universities to create a global model for long-distance engineering education and research. This large-scale experiment, the first truly global collaboration in graduate engineering education and research, is a model for today’s distance education.

1999 The University of Cambridge and MIT establish the Cambridge-MIT Institute, whose programs include student and faculty exchanges, an integrated research program, professional practice education, and a national competitiveness network in Britain.

1999 MIT establishes the Society of Presidential Fellows to honor the most outstanding students worldwide entering the Institute’s graduate programs. With gifts provided by lead donors, presidential fellows are awarded fellowships that fund first year tuition and living expenses.

2000 MIT Faculty approve the Communication Requirement (CR), which went into effect for the Class of 2005. The CR integrates substantial instruction and practice in writing and speaking into all four years and across all parts of MIT’s undergraduate program. Students participate regularly in activities designed to develop both general and technical communication skills.

2001 Studio Physics is introduced to teach freshman physics. Incorporating a highly collaborative, hands-on environment that uses networked laptops and desktop experiments, the new curriculum lets students work directly with complicated and unfamiliar concepts as their professors introduce them.

2001 MIT launches OpenCourseWare, a program that makes materials for nearly all of its courses freely available on the web and serves as a model for sharing knowledge to benefit all humankind.

2001 MIT establishes WebLab, a microelectronics teaching laboratory that allows students to interact remotely on the Web with transistors and other microelectronics devices anywhere and at any time.
2001 MIT’s Earth System Initiative launches TerraScope, a freshman course in which students work in teams to solve complex earth sciences problems. Bringing together physics, mathematics, chemistry, biology, management, and communications, the course has enabled students to devise strategies for preserving tropical rainforests, understand the costs and the benefits of oil drilling in the Arctic National Wildlife Refuge, and plan a mission to Mars.

2002 To give engineering students the opportunity to develop the skills they’ll need to be leaders in the workplace, MIT introduces the Undergraduate Practice Opportunities Program (UPOP). The program involves a corporate training workshop, job seminars taught by alumni, and a 10-week summer internship.

2003 MIT Libraries introduce DSpace, a digital repository that gathers, stores, and preserves the intellectual output of MIT’s faculty and research staff, and makes it freely available to research institutions worldwide. Within a year of its launch, DSpace material had been downloaded more than 8,000 times, and more than 100 organizations had adopted the system for their own use.

2003 MIT’s Program in Computational and Systems Biology (CSBi), an Institute-wide program linking biology, engineering, and computer science in a systems biology approach to the study of cell-to-cell signaling, tissue formation, and cancer, begins accepting students for a new Ph.D. program that will give them the tools for treating biological entities as complex living systems.

2005 Combining courses from engineering, mathematics, and management, MIT launches its master’s program in Computation for Design and Optimization, one of the first curriculums in the country to focus on the computational modeling and design of complex engineered systems. The program prepares engineers for the challenges of making systems ranging from computational biology to airline scheduling to telecommunications design and operations run with maximum effectiveness and efficiency.

2006 MIT creates the Campaign for Students, a fundraising effort dedicated to enhancing the educational experience at MIT through creating scholarships and fellowships, and supporting multidisciplinary education and student life.

2007 MIT makes material from virtually all MIT courses available online for free on OpenCourseWare. The publication marks the beginning of a worldwide movement toward open education that now involves more than 160 universities and 5,000 courses.

2009 MIT launches the Bernard M. Gordon-MIT Engineering Leadership Program. Through interaction with industry leaders, faculty, and fellow students, the program aims to help undergraduate engineering students develop the skills, tools, and character they will need as future engineering leaders.

2009 MIT introduces a minor in energy studies, open to all undergraduates. The new minor, unlike most energy concentrations available at other institutions, and unlike any other concentration at MIT, is designed to be inherently cross-disciplinary, encompassing all of MIT’s five schools. It can be combined with any major subject. The minor aims to allow students to develop expertise and depth in their major disciplines, but then complement that with the breadth of understanding offered by the energy minor.

2010 MIT introduces the flexible engineering degree for undergraduates. The degree, the first of its kind, allows students to complement a deep disciplinary core with an additional subject concentration. The additional concentration can be broad and interdisciplinary in nature (energy, transportation, or the environment), or focused on areas that can be applied to multiple fields (robotics and controls, computational engineering, or engineering management).

2011 MIT announces MITx, an online learning initiative that will offer a portfolio of free MIT courses through an online interactive learning platform. The Institute expects the platform to enhance the educational experience of its on-campus students and serve as a host for a virtual community of millions of learners around the world. The MITx prototype course—6.002x or “Circuits and Electronics”—debuts in March 2012 with almost 155,000 people registering for the course.
Education Highlights
(continued)

2012 MIT and Harvard University announce edX, a transformational new partnership in online education. Through edX, the two institutions will collaborate to enhance campus-based teaching and learning and build a global community of online learners. An open-source technology platform will deliver online courses that move beyond the standard model of online education that relies on watching video content and will offer an interactive experience for students. The University of California at Berkeley later joins edX. The three institutions offer the first edX courses in fall 2012.

2012 Lincoln Laboratory debuts a new outreach program—a two-week summer residential program for high-school students. The program, Lincoln Laboratory Radar Introduction for Student Engineers, focuses on radar technology. The project-based curriculum is based on a popular class offered during MIT’s Independent Activities Period (IAP) and taught by Laboratory technical staff. While the instructors adapted the IAP course to suit high-school students, they retained the challenging nature of the original class. The goal of the program is that students take away not only an understanding of radar systems but also the realization that engineering is about problem-solving and applying knowledge in innovative ways.

Research Highlights

The following are selected research achievements of MIT faculty and staff over the last four decades.

1969 Ioannis V. Yannas begins to develop artificial skin—a material used successfully to treat burn victims.

1970 David Baltimore reports the discovery of reverse transcriptase, an enzyme that catalyzes the conversion of RNA to DNA. The advance, which led to a Nobel Prize for Baltimore in 1975, provided a new means for studying the structure and function of genes.

1973 Jerome Friedman and Henry Kendall, with Stanford colleague Richard Taylor, complete a series of experiments confirming the theory that protons and neutrons are made up of minute particles called quarks. The three receive the 1990 Nobel Prize in Physics for their work.

1974 Samuel C. C. Ting, Ulrich Becker, and Min Chen discover the “J” particle. The discovery, which earns Ting the 1976 Nobel Prize in Physics, points to the existence of one of the six postulated types of quarks.

1975–1977 Barbara Liskov and her students design the CLU programming language, an object-oriented language that helps form the underpinnings for languages like Java and C++. As a result of this work and other accomplishments, Liskov later wins the Turing Award, considered the Nobel Prize in computing.

1975–1982 Joel Moses develops the first extensive computerized program (MACSYMA) able to manipulate algebraic quantities and perform symbolic integration and differentiation.

1976 H. Gobind Khorana and his research team complete chemical synthesis of the first human-manufactured gene fully functional in a living cell. The culmination of 12 years of work, it establishes the foundation for the biotechnology industry. Khorana won the 1968 Nobel Prize in Physiology/Medicine for other genetics work.

1977 Phillip Sharp discovers the split gene structure of higher organisms, changing the view of how genes arose during evolution. For this work, Sharp shared the 1993 Nobel Prize in Physiology/Medicine.
1977 Ronald Rivest, Adi Shamir, and Leonard Adleman invent the first workable public key cryptographic system. The new code, which is based on the use of very large prime numbers, allows secret communication between any pair of users. Still unbroken, the code is in widespread use today.

1979 Robert Weinberg reports isolating and identifying the first human oncogene—an altered gene that causes the uncontrolled cell growth that leads to cancer.

1981 Alan Guth publishes the first satisfactory model of the universe’s development in the first 10–32 seconds after the Big Bang.

1982 Alan Davison discovers a new class of technetium compounds that leads to the development of the first diagnostic technetium drug for imaging the human heart.

1985 Susumu Tonegawa describes the structure of the gene for the receptors—“anchor molecules”—on the white blood cells called T lymphocytes, the immune system’s master cells. In 1987, Tonegawa receives the Nobel Prize in Physiology/Medicine for similar work on the immune system’s B cells.

1986 H. Robert Horvitz identifies the first two genes found to be responsible for the process of cell death, which is critical both for normal body development and for protection against autoimmune diseases, cancer, and other disorders. Going on to make many more pioneering discoveries about the genetics of cell death, Horvitz shares the 2002 Nobel Prize in Physiology/Medicine for his work.

1988 Sallie Chisholm and associates report the discovery of a form of ocean plankton that may be the most abundant single species on earth.

1990 Julius Rebek, Jr. and associates create the first self-replicating synthetic molecule.

1990 Building on the discovery of the metathesis—the process of cutting carbon-carbon double bonds in half and constructing new ones—Richard Schrock devises a catalyst that greatly speeds up the reaction, consumes less energy, and produces less waste. A process based on his discovery is now in widespread use for efficient and more environmentally friendly production of important pharmaceuticals, fuels, synthetic fibers, and many other products. Schrock shares the 2005 Nobel Prize in Chemistry for his breakthrough.

1991 Cleveland heart doctors begin clinical trials of a laser catheter system for microsurgery on the arteries that is largely the work of Michael Feld and his MIT associates.

1993 H. Robert Horvitz, together with scientists at Massachusetts General Hospital, discover an association between a gene mutation and the inherited form of amyotrophic lateral sclerosis (Lou Gehrig’s disease).

1993 David Housman joins colleagues at other institutions in announcing a successful end to the long search for the genetic defect linked with Huntington’s disease.

1993 Alexander Rich and postdoctoral fellow Shuguang Zhang report the discovery of a small protein fragment that spontaneously forms into membranes. This research will lead to advances in drug development, biomedical research, and the understanding of Alzheimer’s and other diseases.

1994 MIT engineers develop a robot that can “learn” exercises from a physical therapist, guide a patient through them, and—for the first time—record biomedical data on the patient’s condition and progress.

1995 Scientists at the Whitehead Institute for Biomedical Research and MIT create a map of the human genome and begin the final phase of the Human Genome Project. This powerful map contains more than 15,000 distinct markers and covers virtually all of the human genome.

1996 A group of scientists at MIT’s Center for Learning and Memory, led by Matthew Wilson and Nobel laureate Susumu Tonegawa, use new genetic and multiple-cell monitoring technologies to demonstrate how animals form memory about new environments.

1997 MIT physicists create the first atom laser, a device that is analogous to an optical laser but emits atoms instead of light. The resulting beam can be focused to a pinpoint or made to travel long distances with minimal spreading.
Research Highlights
(continued)

1998 MIT biologists, led by Leonard Guarente, identify a mechanism of aging in yeast cells that suggests researchers may one day be able to intervene in, and possibly inhibit, the aging process in certain human cells.

1998 An interdisciplinary team of MIT researchers, led by Yoel Fink and Edwin L. Thomas, invent the “perfect mirror,” which offers radical new ways of directing and manipulating light. Potential applications range from a flexible light guide that can illuminate specific internal organs during surgery to new devices for optical communications.

1999 Michael Cima, Robert Langer, and graduate student John Santini report the first microchip that can store and release chemicals on demand. Among its potential applications is a “pharmacy” that could be swallowed or implanted under the skin and programmed to deliver precise drug dosages at specific times.

1999 Alexander Rich leads a team of researchers in the discovery that left-handed DNA (also known as Z-DNA) is critical for the creation of important brain chemicals. Having first produced Z-DNA synthetically in 1979, Rich succeeds in identifying it in nature in 1981. He also discovers its first biological role and receives the National Medal of Science for this pioneering work in 1995.

2000 Scientists at the Whitehead Institute/MIT Center for Genome Research and their collaborators announce the completion of the Human Genome Project. Providing about a third of all the sequences assembled, the center was the single largest contributor to this international enterprise.

2000 Researchers develop a device that uses ultrasound to extract a number of important molecules noninvasively and painlessly through the skin. They expect that the first application will be a portable device for noninvasive glucose monitoring for diabetics.

2000 Researchers from the MIT Sloan School of Management launch the Social and Economic Explorations of Information Technology (SeeIT) Project, the first empirical study of the effects of information technology (IT) on organizational and work practices. Examining IT’s relationship to changes in these models, SeeIT provides practical data for understanding and evaluating IT’s business and economic effects, which will enable us to take full advantage of its opportunities and better control its risks.

2001 In a step toward creating energy from sunlight as plants do, Daniel Nocera and a team of researchers invent a compound that, with the help of a catalyst and energy from light, produces hydrogen.

2002 MIT researchers create the first acrobatic robotic bird—a small, highly agile helicopter for military use in mountain and urban combat.

2002–2005 Scientists at MIT, the Whitehead Institute for Biomedical Research, and the Broad Institute complete the genomes of the mouse, the dog, and four strains of phytoplankton, photosynthetic organisms that are critical for the regulation of atmospheric carbon dioxide. They also identify the genes required to create a zebrafish embryo. In collaboration with scientists from other institutions, they map the genomes of chimpanzees, humans’ closest genetic relative, and the smallest known vertebrate, the puffer fish.

2003 MIT scientists cool a sodium gas to the lowest temperature ever recorded—a half-a-billionth of a degree above absolute zero. Studying these ultralow temperature gases will provide valuable insights into the basic physics of matter; and by facilitating the development of better atomic clocks and sensors for gravity and rotation, they also could lead to vast improvements in precision measurements.

2004 MIT’s Levitated Dipole Experiment, a collaboration among scientists at MIT and Columbia, generates a strong dipole magnetic field that enables them to experiment with plasma fusion, the source of energy that powers the sun and stars, with the goal of producing it on Earth. Because the hydrogen that fuels plasma fusion is practically limitless and the energy it produces is clean and doesn’t contribute to global warming, fusion power will be of enormous benefit to humankind and to earth systems in general.
2004 A team led by neuroscientist Mark Bear illuminates the molecular mechanisms underlying Fragile X Syndrome and shows that it might be possible to develop drugs that treat the symptoms of this leading known inherited cause of mental retardation, whose effects range from mild learning disabilities to severe autism.

2004 Shuguang Zhang, Marc A. Baldo, and recent graduate Patrick Kiley, first figure out how to stabilize spinach proteins—which, like all plants, produce energy when exposed to light—so they can survive without water and salt. Then, they devise a way to attach them to a piece of glass coated with a thin layer of gold. The resulting spinach-based solar cell, the world’s first solid-state photosynthetic solar cell, has the potential to power laptops and cell phones with sunlight.

2005 MIT physicists, led by Nobel laureate Wolfgang Ketterle, create a new type of matter, a gas of atoms that shows high-temperature superfluidity.

2005 Vladimir Bulovic and Tim Swager develop lasing sensors based on a semiconducting polymer that is able to detect the presence of TNT vapor subparts per billion concentrations.

2006 MIT launches the MIT Energy Initiative (MITEI) to address world energy problems. Led by Ernest J. Moniz and Robert C. Armstrong, MITEI coordinates energy research, education, campus energy management, and outreach activities across the Institute.


2007 Tim Jamison discovers that cascades of epoxide-opening reactions that were long thought to be impossible can very rapidly assemble the Red Tide marine toxins when they are induced by water. Such processes may be emulating how these toxins are made in nature and may lead to a better understanding of what causes devastating Red Tide phenomena. These methods also open up an environmentally green synthesis of new classes of complex highly biologically active compounds.

2007 MIT mathematicians form part of a group of 18 mathematicians from the U.S. and Europe that maps one of the most complicated structures ever studied: the exceptional Lie group E8. The “answer” to the calculation, if written, would cover an area the size of Manhattan. The resulting atlas has applications in the fields of string theory and geometry.

2007 Marin Soljačić and his colleagues develop a new form of wireless power transmission they call WITricity. It is based on a strongly coupled magnetic resonance and can be used to transfer power over distances of a few meters with high efficiency. The technique could be used commercially to wirelessly power laptops, cell phones, and other devices.

2008 Mriganka Sur’s laboratory discovers that astrocytes, star-shaped cells in the brain that are as numerous as neurons, form the basis for functioning brain imaging. Using ultra high-resolution imaging in the intact brain, they demonstrate that astrocytes regulate blood flow to active brain regions by linking neurons to brain capillaries.

2008 A team led by Marc A. Baldo designs a solar concentrator that focuses light at the edges of a solar power cell. The technology can increase the efficiency of solar panels by up to 50 percent, substantially reducing the cost of generating solar electricity.

2008 Daniel Nocera creates a chemical catalyst that hurdles one of the obstacles to widespread use of solar power—the difficulty of storing energy from the sun. The catalyst, which is cheap and easy to make, uses the energy from sunlight to separate the hydrogen and oxygen molecules in water. The hydrogen can then be burned, or used to power an electric fuel cell.
**Research Highlights (continued)**

**2009** A team of MIT researchers led by Angela Belcher reports that it is able to genetically engineer viruses to produce both the positively and negatively charged ends of a lithium-ion battery. The battery has the same energy capacity as those being considered for use in hybrid cars, but is produced using a cheaper, less environmentally hazardous process. MIT President Susan Hockfield presents a prototype battery to President Barack Obama at a press briefing at the White House.

**2009** Researchers at MIT’s Picower Institute for Learning and Memory show for the first time that multiple interacting genetic risk factors may influence the severity of autism symptoms. The finding could lead to therapies and diagnostic tools that target the interacting genes.

**2009** Gerbrand Ceder and graduate student Byoungwoo Kang develop a new way to manufacture the material used in lithium ion batteries that allows ultra fast charging and discharging. The new method creates a surface structure that allows lithium ions to move rapidly around the outside of the battery. Batteries built using the new method could take seconds, rather than the now standard hours, to charge.

**2009** As neuroscience progresses rapidly toward an understanding of basic mechanisms of neural and synapse function, MIT neuroscientists are discovering the mechanisms underlying brain disorders and diseases. Li-Huei Tsai’s laboratory describes mechanisms that underlie Alzheimer’s disease and propose that inhibition of histone deacetylases is therapeutic for degenerative disorders of learning and memory. Her laboratory also discovers the mechanisms of action of the gene Disrupted-in-Schizophrenia 1 and demonstrates why drugs such as lithium are effective in certain instances of schizophrenia. This research opens up pathways to discovering novel classes of drugs for devastating neuropsychiatric conditions.

**2010** A new approach to desalination is being developed by researchers at MIT and in Korea that could lead to small, portable desalination units that could be powered by solar cells or batteries and could deliver enough fresh water to supply the needs of a family or small village. As an added bonus, the system would remove many contaminants, viruses, and bacteria at the same time.

**2010** Yang Shao-Horn, with some of her students, and visiting professor Hubert Gasteiger, reports that lithium-oxygen (also known as lithium-air) batteries with electrodes with either gold or platinum as a catalyst have a higher efficiency than simple carbon electrodes. Lithium-air batteries are lighter than the conventional lithium-ion batteries.

**2010** A team at Media Lab, including Ramesh Raskar, visiting professor Manuel Oliveira, student Vitor Pamplona, and postdoctoral research associate Ankit Mohan, create a new system to determine a prescription for eyeglasses. In its simplest form, the test can be carried out using a small, plastic device clipped onto the front of a cellphone’s screen.

**2010** MIT releases *The Future of Natural Gas* report. The two-year study, managed by the MIT Energy Initiative, examines the scale of U.S. natural gas reserves and the potential of this fuel to reduce greenhouse-gas emissions. While the report emphasizes the great potential for natural gas as a transitional fuel to help curb greenhouse gases and dependence on oil, it also stresses that it is important as a matter of national policy not to favor any one fuel or energy source in a way that puts others at a disadvantage.

**2010** Michael Strano and his team of graduate students and researchers create a set of self-assembling molecules that can turn sunlight into electricity; the molecules can be repeatedly broken down and reassembled quickly just by adding or removing an additional solution.

**2011** Elazer Edelman, HST graduate student Joseph Franses, and former MIT postdoctoral fellows Aaron Baker and Vipul Chitalia show that cells lining blood vessels secrete molecules that suppress tumor growth and prevent cancer cells from invading other tissues, a finding that could lead to a new cancer treatment.
2011 The Alpha Magnetic Spectrometer (AMS)—an instrument designed to use the unique environment of space to search for antimatter and dark matter and to measure cosmic rays—is delivered to the International Space Station. The AMS experiment, led by Samuel C. C. Ting, is designed to study high-energy particles; such study could lead to new theories about the formation and evolution of the universe.

2011 A team, including Karen Gleason, Vladimir Bulović, and graduate student Miles Barr, develops materials that make it possible to produce photovoltaic cells on paper or fabric, nearly as simply as printing a document. The technique represents a major departure from the systems typically used to create solar cells, which require exposing the substrates to potentially damaging conditions, either in the form of liquids or high temperatures.

2011 By combining a physical interface with computer-vision algorithms, researchers in MIT’s Department of Brain and Cognitive Sciences create a simple, portable imaging system that can achieve resolutions previously possible only with large and expensive lab equipment. The device could allow manufacturers to inspect products too large to fit under a microscope and could also have applications in medicine, forensics, and biometrics. Moreover, because the design uses multiple cameras, it can produce 3-D models of an object, which can be manipulated on a computer screen for examination from multiple angles.

2011 Researchers, led by Daniel Nocera, have produced an “artificial leaf”—a silicon solar cell with different catalytic materials bonded onto its two sides. The artificial leaf can turn the energy of sunlight directly into a chemical fuel that can be stored and used later as an energy source.

2011 Lincoln Laboratory researchers, led by technical staff member Gregory Charvat, build a new radar technology system that can see through walls up to 60 feet away, creating an instantaneous picture of the activity on the other side. The system also creates a real-time video of movement behind the wall at the rate of 10.8 frames per second.

2012 NASA’s Gravity Recovery And Interior Laboratory (GRAIL) twin spacecraft successfully enters lunar orbit. By precisely measuring changes in distance between the twin orbiting spacecraft, scientists will construct a detailed gravitational model of the moon that will be used to answer fundamental questions about the moon’s evolution and its internal composition. GRAIL’s principal investigator is Maria Zuber.

2012 Researchers, including Jeffrey Grossman, discover that building cubes or towers of solar cells—to extend the cells upward in three-dimensional configurations—generates two to 20 times the power produced by fixed flat panels with the same base area.

2012 Researchers, led by Ian Hunter, have engineered a device that delivers a tiny, high-pressure jet of medicine through the skin without the use of a hypodermic needle. The device can be programmed to deliver a range of doses to various depths—an improvement over similar jet-injection systems that are now commercially available.

2012 A clinical trial of an Alzheimer’s disease treatment developed at MIT finds that a nutrient cocktail can improve memory in patients with early Alzheimer’s. Richard Wurtman invented the supplement mixture, known as Souvenaid, which appears to stimulate growth of new synapses.
**Faculty and Staff**

MIT employs approximately 11,000 persons on campus. In addition to the faculty, there are research, library, and administrative staff, and many others who, directly or indirectly, support the teaching and research goals of the Institute.

**Faculty and Staff, 2012–2013**

<table>
<thead>
<tr>
<th>Employee Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>1,022</td>
</tr>
<tr>
<td>Other academic and instructional staff</td>
<td>889</td>
</tr>
<tr>
<td>Research staff and research scientists (includes postdoctoral positions)</td>
<td>3,077</td>
</tr>
<tr>
<td>Administrative staff</td>
<td>2,509</td>
</tr>
<tr>
<td>Support staff</td>
<td>1,505</td>
</tr>
<tr>
<td>Service staff</td>
<td>804</td>
</tr>
<tr>
<td>Clinical and Medical staff</td>
<td>103</td>
</tr>
<tr>
<td>Affiliated faculty, scientists, and scholars</td>
<td>1,087</td>
</tr>
<tr>
<td><strong>Total campus faculty and staff</strong></td>
<td><strong>10,996</strong></td>
</tr>
</tbody>
</table>

Faculty are divided among various schools.

Approximately 590 graduate students serve as teaching assistants or instructors, and 2,490 graduate students serve as research assistants.

MIT Lincoln Laboratory employs about 3,440 people, primarily at Hanscom Air Force Base in Lexington, Massachusetts. See page 76 for additional Lincoln Laboratory staffing information.

**Faculty**

The MIT faculty instruct undergraduate and graduate students, and engage in research and service.

**Faculty Profile, 2012–2013**

<table>
<thead>
<tr>
<th></th>
<th>Count</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professors</td>
<td>659</td>
<td>65</td>
</tr>
<tr>
<td>Associate professors</td>
<td>206</td>
<td>20</td>
</tr>
<tr>
<td>Assistant professors</td>
<td>157</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,022</strong></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td>Male</td>
<td>803</td>
<td>79</td>
</tr>
<tr>
<td>Female</td>
<td>219</td>
<td>21</td>
</tr>
</tbody>
</table>

See page 30 for a chart of faculty and students from 1865–2013.

Seventy-seven percent of faculty are tenured.

Faculty may hold dual appointments where they are appointed equally to two departments. Thirty faculty members have dual appointments.

**Faculty by School, 2012–2013**

<table>
<thead>
<tr>
<th>School</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture and Planning</td>
<td>78</td>
<td>8</td>
</tr>
<tr>
<td>Engineering</td>
<td>383</td>
<td>37</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences</td>
<td>162</td>
<td>16</td>
</tr>
<tr>
<td>Science</td>
<td>274</td>
<td>27</td>
</tr>
<tr>
<td>Management</td>
<td>112</td>
<td>11</td>
</tr>
<tr>
<td>Other</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,022</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Sixty-four percent of the faculty are in science and engineering fields.
Nineteen percent of faculty are members of a minority group; seven percent are members of an underrepresented minority. Ethnicity is self identified. Faculty members may identify as part of multiple groups.

**Faculty Minority Group, 2012–2013**

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian</td>
<td>29</td>
<td>97</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>4</td>
<td>34</td>
</tr>
<tr>
<td>African American</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>American Indian or Alaskan Native</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Forty-one percent of current faculty are internationally born. Over seventy countries are represented by these faculty members.

![Country of Origin of Internationally Born Faculty, 2012–2013]

![Years at MIT of Faculty, 2012–2013 (excludes time as student)]
Researchers

MIT campus research staff and scientists total 3,077. These researchers work with MIT faculty and students on projects funded by government, nonprofits and foundations, and industry.

<table>
<thead>
<tr>
<th>Employee Type</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principle Researchers</td>
<td>121</td>
</tr>
<tr>
<td>Senior Researchers</td>
<td>57</td>
</tr>
<tr>
<td>Research Scientists and Technicians</td>
<td>995</td>
</tr>
<tr>
<td>Visiting Scientists</td>
<td>463</td>
</tr>
<tr>
<td>Postdoctoral Associates</td>
<td>1,009</td>
</tr>
<tr>
<td>Postdoctoral Fellows</td>
<td>432</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,077</strong></td>
</tr>
</tbody>
</table>

Approximately 2,490 graduate students received primary appointments as research assistants.
Postdoctoral Scholars
As of October 31, 2012, MIT hosts 1,441 postdoctoral associates and fellows—388 females and 1,053 males. These individuals work with faculty in academic departments, laboratories, and centers.

U.S. Citizen and Permanent Resident Postdoctoral Scholars, 2012–2013

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hispanic or Latino</td>
<td>25</td>
</tr>
<tr>
<td>African American</td>
<td>8</td>
</tr>
<tr>
<td>American Indian or Alaskan Native</td>
<td>0</td>
</tr>
<tr>
<td>Total underrepresented minorities (URM)</td>
<td>33</td>
</tr>
<tr>
<td>White</td>
<td>223</td>
</tr>
<tr>
<td>Asian</td>
<td>55</td>
</tr>
<tr>
<td>Two or more races</td>
<td>3</td>
</tr>
<tr>
<td>Unknown</td>
<td>227</td>
</tr>
<tr>
<td>Total</td>
<td>541</td>
</tr>
</tbody>
</table>

International Postdoctoral Scholars, 2012–2013

<table>
<thead>
<tr>
<th>Country of Citizenship</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>184</td>
<td>20</td>
</tr>
<tr>
<td>South Korea</td>
<td>78</td>
<td>9</td>
</tr>
<tr>
<td>India</td>
<td>65</td>
<td>7</td>
</tr>
<tr>
<td>Germany</td>
<td>62</td>
<td>7</td>
</tr>
<tr>
<td>Canada</td>
<td>54</td>
<td>6</td>
</tr>
<tr>
<td>France</td>
<td>42</td>
<td>5</td>
</tr>
<tr>
<td>Israel</td>
<td>40</td>
<td>4</td>
</tr>
<tr>
<td>Italy</td>
<td>36</td>
<td>4</td>
</tr>
<tr>
<td>Japan</td>
<td>33</td>
<td>4</td>
</tr>
<tr>
<td>All other countries</td>
<td>306</td>
<td>34</td>
</tr>
<tr>
<td>Total</td>
<td>900</td>
<td>100</td>
</tr>
</tbody>
</table>

Postdoctoral scholars come from 69 foreign countries.

Years at MIT of Postdoctoral Scholars, 2012–2013

![Bar chart showing the number of postdoctoral scholars at MIT by years of stay, with a breakdown by gender.](chart.png)
Awards and Honors of Current Faculty and Staff

Nine current faculty members at MIT have received the Nobel Prize:

H. Robert Horvitz  Nobel Prize in Physiology or Medicine (shared)
Wolfgang Ketterle  Nobel Prize in Physics (shared)
Robert C. Merton  Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel (shared)
Richard R. Schrock  Nobel Prize in Chemistry (shared)
Phillip A. Sharp  Nobel Prize in Physiology or Medicine (shared)
Susan Solomon  Nobel Peace Prize (co-chair of Working Group One recognized under Intergovernmental Panel on Climate Change (IPCC), shared)
Samuel C. C. Ting  Nobel Prize in Physics (shared)
Susumu Tonegawa  Nobel Prize in Physiology or Medicine
Frank Wilczek  Nobel Prize in Physics (shared)

Below is a summary of selected awards and honors of current faculty and staff.

Number of Recipients  Award Name and Agency
150  American Academy of Arts and Sciences Member
91  American Association for the Advancement of Science Fellow
12  American Philosophical Society Member
83  American Physical Society Fellow
17  American Society of Mechanical Engineers Fellow
23  Association for Computing Machinery Fellow
4  John Bates Clark Medal, American Economic Association
3  Dirac Medal, Abdus Salam International Centre for Theoretical Physics
6  Fulbright Scholar, Council for International Exchange of Scholars (CIES)
7  Gairdner Award, Gairdner Foundation
71  Guggenheim Fellow, John Simon Guggenheim Memorial Foundation
18  HHMI Investigator, Howard Hughes Medical Institute (HHMI)
55  Institute of Electrical and Electronics Engineers, Inc. Fellow
33  Institute of Medicine Member, National Academies
1  Japan Prize, Science and Technology Foundation of Japan
2  Kavli Prize, Norwegian Academy of Science and Letters
20  MacArthur Fellow, John D. and Catherine T. MacArthur Foundation
66  Millennium Technology Prize, Millennium Prize Foundation
66  National Academy of Engineering Member, National Academies
79  National Academy of Sciences Member, National Academies
11  National Medal of Science, National Science & Technology Medals Foundation
1  National Medal of Technology and Innovation, National Science & Technology Medals Foundation
2  Rolf Nevanlinna Prize, International Mathematical Union (IMU)
31  Presidential Early Career Awards for Scientists and Engineers (PECASE)
3  Pulitzer Prize, Pulitzer Board
4  Royal Academy of Engineering Fellow, Royal Academy of Engineering
5  A. M. Turing Award, Association for Computing Machinery
1  Von Hippel Award, Materials Research Society
3  John von Neumann Medal, Institute of Electrical and Electronics Engineers, Inc.
3  Alan T. Waterman Award, National Science Foundation
3  Wolf Prize, Wolf Foundation
Award Highlights

Amy Finkelstein
2012 John Bates Clark Medal
MIT economist Amy Finkelstein, a leader in studying health insurance markets, is the 2012 recipient of the prestigious John Bates Clark Medal, an annual award given by the American Economic Association (AEA). The Clark Medal is given to an economist under the age of 40 “who is judged to have made the most significant contribution to economic thought and knowledge,” according to the AEA.

Mildred Dresselhaus, Ann Graybiel, and Jane Luu
2012 Kavli Prizes
Mildred Dresselhaus, professor emerita, Ann Graybiel and Jane Luu are among seven pioneering scientists worldwide named as 2012 recipients of the Kavli Prizes. These prizes recognize scientists for their seminal advances in astrophysics, nanoscience, and neuroscience. The 2012 laureates were selected for their fundamental contributions to our understanding of the outer solar system; the differences in material properties at the nanoscale and at larger scales; and how the brain receives and responds to sensations such as sight, sound, and touch.

Pablo Jarillo-Herrero, Timothy K. Lu, Parag A. Pathak, Pawan Sinha, and Jesse Thaler
2012 Presidential Early Career Awards for Scientists and Engineers
Five members of the faculty are 2012 recipients of Presidential Early Career Award for Scientists and Engineers (PECASE), the highest honor bestowed by the U.S. government on science and engineering professionals in the early stages of their independent research careers. Pablo Jarillo-Herrero, Timothy K. Lu ’03, MEng ’03, PhD ’08, Parag A. Pathak, Pawan Sinha SM ’92, PhD ’95, and Jesse Thaler are among 96 honored. Currently, 30 faculty members and one staff member are recipients of the PECASE award, including the 2012 recipients.

Michael Artin and Robert Langer
2013 Wolf Prize
Michael Artin, professor emeritus, and Robert Langer are among eight recipients worldwide of the 2013 Wolf Prize given by the Israel-based Wolf Foundation. The prestigious international prizes are awarded annually in agriculture, chemistry, mathematics, medicine, and/or physics, as well as in the arts. Artin and Langer were cited for their contributions in mathematics and chemistry, respectively. More than 30 Wolf Prize recipients have gone on to win the Nobel Prize.
Section 2
Students

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Students

The Institute’s fall 2012 student body of 11,189 is highly diverse. Students come from all 50 states, the District of Columbia, three territories and dependencies, and 117 foreign countries. The Institute’s 3,167 international students make up ten percent of the undergraduate population and 40 percent of the graduate population. See pages 96-98 for more information about international students.

<table>
<thead>
<tr>
<th>Student Profile, 2012–2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Level</td>
</tr>
<tr>
<td>Undergraduate</td>
</tr>
<tr>
<td>Graduate</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

In fall 2012, 45 percent of MIT’s first-year students (who reported their class standing) were first in their high school class; 92 percent ranked in the top five percent.

Student Minorities, 2012–2013*

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Undergraduate</th>
<th>Graduate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian American</td>
<td>1,083</td>
<td>754</td>
</tr>
<tr>
<td>Hispanic or Latino</td>
<td>687</td>
<td>325</td>
</tr>
<tr>
<td>African American</td>
<td>278</td>
<td>119</td>
</tr>
<tr>
<td>Two or more races</td>
<td>188</td>
<td>127</td>
</tr>
<tr>
<td>American Indian or Alaskan Native</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>2,250</td>
<td>1,339</td>
</tr>
</tbody>
</table>

*Data is for U.S. citizens and permanent residents. These figures may not precisely reflect the population because they are self-reported, and not all students choose to identify an ethnicity or race. One-hundred thirty-five undergraduates and 495 graduate students chose not to identify an ethnicity or race.

Students who identified at least in part as a U.S. minority group totaled 3,589—50% of undergraduate and 20% of graduate students.
Undergraduate Students

Students first enrolled at MIT in 1865. Twenty-seven students enrolled as undergraduate students that first year. In fall 2012, there were 4,503 undergraduate students.

Undergraduate Students, 2012–2013

<table>
<thead>
<tr>
<th>Citizenship</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. citizen</td>
<td>3,748</td>
<td>83.2</td>
</tr>
<tr>
<td>U.S. permanent resident</td>
<td>287</td>
<td>6.4</td>
</tr>
<tr>
<td>International</td>
<td>468</td>
<td>10.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,503</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Undergraduate Students by Gender, 2012–2013

<table>
<thead>
<tr>
<th>Gender</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>2,038</td>
</tr>
<tr>
<td>Male</td>
<td>2,465</td>
</tr>
</tbody>
</table>

Undergraduate Students by School, 2012–2013

<table>
<thead>
<tr>
<th>School</th>
<th>Undergraduates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture and Planning</td>
<td>52</td>
</tr>
<tr>
<td>Engineering</td>
<td>2,178</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences</td>
<td>129</td>
</tr>
<tr>
<td>Management</td>
<td>97</td>
</tr>
<tr>
<td>Science</td>
<td>872</td>
</tr>
<tr>
<td>Undesignated*</td>
<td>1,175</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,503</strong></td>
</tr>
</tbody>
</table>

*Undesignated comprises freshman who do not enroll in a major and undesignated sophomores.
Graduate Students
Graduate students have outnumbered undergraduate students at MIT since 1980. In fall 2012, they comprised 60 percent of the student population with 6,686 students—2,904 master’s students (includes 163 non-matriculating) and 3,782 doctoral students.

Graduate Students, 2012–2013

<table>
<thead>
<tr>
<th>Citizenship</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. citizen</td>
<td>3,736</td>
<td>56</td>
</tr>
<tr>
<td>U.S. permanent resident</td>
<td>251</td>
<td>4</td>
</tr>
<tr>
<td>International</td>
<td>2,699</td>
<td>40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6,686</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Graduate Students by Gender, 2012–2013

<table>
<thead>
<tr>
<th>Citizenship</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. citizen</td>
<td>2,636</td>
<td>1,146</td>
</tr>
<tr>
<td>U.S. permanent resident</td>
<td>251</td>
<td>938</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3,887</strong></td>
<td><strong>2,084</strong></td>
</tr>
</tbody>
</table>

Graduate Students by School, 2012–2013

<table>
<thead>
<tr>
<th>School</th>
<th>Master’s*</th>
<th>Doctoral</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture and Planning</td>
<td>389</td>
<td>185</td>
<td>574</td>
</tr>
<tr>
<td>Engineering</td>
<td>1,070</td>
<td>2,093</td>
<td>3,163</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences</td>
<td>32</td>
<td>280</td>
<td>312</td>
</tr>
<tr>
<td>Management</td>
<td>1,241</td>
<td>138</td>
<td>1,379</td>
</tr>
<tr>
<td>Science</td>
<td>9</td>
<td>1,086</td>
<td>1,095</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,741</strong></td>
<td><strong>3,782</strong></td>
<td><strong>6,523</strong></td>
</tr>
</tbody>
</table>
Degrees
In 2012–2013, MIT awarded 3,389 degrees.

Degrees Awarded by Type, 2012–2013

<table>
<thead>
<tr>
<th>Degree Type</th>
<th>Degrees Awarded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor of Science degrees</td>
<td>1,042</td>
</tr>
<tr>
<td>Master of Science degrees</td>
<td>752</td>
</tr>
<tr>
<td>Master of Architecture, Master in City Planning, Master of Engineering, Master of Business Administration, and Master of Finance degrees</td>
<td>997</td>
</tr>
<tr>
<td>Engineer’s degrees</td>
<td>11</td>
</tr>
<tr>
<td>Doctoral degrees</td>
<td>587</td>
</tr>
</tbody>
</table>

Degrees Awarded by Gender, 2012–2013

Degrees Awarded by School, 2012–2013

<table>
<thead>
<tr>
<th>School</th>
<th>Bachelor’s</th>
<th>Master’s and Engineer’s</th>
<th>Doctorate</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architecture and Planning</td>
<td>19</td>
<td>181</td>
<td>37</td>
<td>237</td>
</tr>
<tr>
<td>Engineering</td>
<td>647</td>
<td>772</td>
<td>324</td>
<td>1,743</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences</td>
<td>45</td>
<td>24</td>
<td>42</td>
<td>111</td>
</tr>
<tr>
<td>Management</td>
<td>37</td>
<td>750</td>
<td>32</td>
<td>819</td>
</tr>
<tr>
<td>Science</td>
<td>294</td>
<td>33</td>
<td>152</td>
<td>479</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,042</strong></td>
<td><strong>1,760</strong></td>
<td><strong>587</strong></td>
<td><strong>3,389</strong></td>
</tr>
</tbody>
</table>
Alumni

Seventy-five percent of alumni respondents said they have enrolled in a graduate or professional degree program since graduating from MIT. Of those who have enrolled in a graduate or professional degree program, over half did so immediately upon graduation. This includes students who earned a graduate degree simultaneously with their bachelor’s degree. Eighty-five percent of respondents said they are employed either full-time or part-time. An additional 4% are unemployed and seeking employment. The remainder is either on leave or unemployed and not currently seeking employment. Among those respondents who are employed, 64% work in the for-profit sector, 13% work in government or military agencies, 14% work in the nonprofit sector, and 9% are self-employed. Twenty-two percent of respondents reported having started a company. Fourteen percent said they are currently developing a start-up company.

Service is a part of the lives of our alumni. Eighty-seven percent of respondents have served as an officer or on a committee for a local club, organization, or place of worship in the last 10 years. Thirty-seven percent have been a board member for a nonprofit organization. Seventy-three percent have done volunteer work at least once in the last year.

A fall 2012 survey of graduate alumni (http://web.mit.edu/ir/surveys/grad_alum.html) revealed that 93% of respondents are employed, with just 2% seeking employment (others are engaged in such activities as travel and caring for family). The average annual salary was reported to be $156,793; the median was $137,500. Graduate alumni, overall, were most likely to report working in a private for-profit organization (54%), in a U.S. four-year college or university (13%), or to be self-employed (9%). 3.8% were employed by the U.S. federal government; 0.4% by U.S. state government; and 0.7% in U.S. local government. A spirit of entrepreneurship flourishes, as 28% of all surveyed graduate alumni have started a company. Among doctoral alumni, 41% have at least one patent or invention.

MIT’s 126,684 living alumni are connected to the Institute through graduating-class events, departmental organizations, and over 47 clubs in the United States and 42 abroad. More than 12,000 volunteers offer their time, financial support, and service on committees and on the MIT Corporation, the Institute’s Board of Trustees. MIT graduates hold leadership positions in industries and organizations around the world. Over 21,000 alumni reside in Massachusetts, and about 85 percent of MIT’s alumni live in the United States.
**Undergraduate Financial Aid**

Principles of MIT Undergraduate Financial Aid

To ensure that MIT remains accessible to all qualified students regardless of their financial resources, MIT is committed to three guiding financial aid principles:

- **Need-blind admissions:** MIT recruits and enrolls the most talented and promising students without regard to their financial circumstances.

- **Need-based financial aid:** MIT awards aid only for financial need. It does not award undergraduate scholarships for academic or athletic achievements or for other non-financial criteria.

- **Meeting the full need:** MIT guarantees that each student’s demonstrated financial need is fully met.

As a result of these guiding principles, the Institute has historically assumed an increasingly higher percentage of net undergraduate tuition and fees, which reduces the cost to the student. However, 2011 and 2012 saw slight increases in net tuition and fees when compared to total tuition and fees, as exhibited by the chart below.

*Net tuition and fees calculated as gross undergraduate tuition and fees received, minus MIT undergraduate scholarships.*
Who Pays for an MIT Undergraduate Education

In 2011–2012, the annual price of an MIT education totaled $55,670 per student—$40,460 for tuition and fees, $11,775 for room and board, an estimated $2,763 for books, supplies, and personal expenses, and a per-student average of $400 for travel. With 4,363 undergraduates enrolled, the collective price for undergraduates was $242.9 million. Of this amount, families paid $121.1 million, or 50 percent, and financial aid covered the remaining 50 percent.

Since MIT subsidizes the cost of educating undergraduates through its tuition pricing and continues to be the largest source of financial aid to its undergraduates, the Institute is the primary source for paying for an MIT undergraduate education, and families the secondary source.

Additionally, for students who received MIT scholarships, the family share is mainly based on family income with needier families paying a significantly smaller share of the price.

### Average 2011–2012 Scholarship Packages and Share of Price by Family Income for MIT scholarship recipients

<table>
<thead>
<tr>
<th>Family income of MIT undergraduates*</th>
<th>Number of MIT scholarship recipients</th>
<th>Percent of Undergraduates with MIT Scholarship</th>
<th>Average scholarship package ($)†</th>
<th>Percent of Family share of price‡</th>
<th>Percent of Financial aid share of price</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0-25,000</td>
<td>380</td>
<td>98</td>
<td>49,952</td>
<td>10</td>
<td>90</td>
</tr>
<tr>
<td>$25,001-50,000</td>
<td>460</td>
<td>100</td>
<td>48,195</td>
<td>13</td>
<td>87</td>
</tr>
<tr>
<td>$50,001-75,000</td>
<td>385</td>
<td>97</td>
<td>44,298</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>$75,001-100,000</td>
<td>370</td>
<td>97</td>
<td>37,621</td>
<td>32</td>
<td>68</td>
</tr>
<tr>
<td>$100,001-125,000</td>
<td>320</td>
<td>95</td>
<td>31,696</td>
<td>43</td>
<td>57</td>
</tr>
<tr>
<td>$125,001-150,000</td>
<td>306</td>
<td>91</td>
<td>24,049</td>
<td>57</td>
<td>43</td>
</tr>
<tr>
<td>$150,001-175,000</td>
<td>212</td>
<td>83</td>
<td>18,511</td>
<td>67</td>
<td>33</td>
</tr>
<tr>
<td>$175,001-200,000</td>
<td>108</td>
<td>65</td>
<td>15,515</td>
<td>72</td>
<td>28</td>
</tr>
<tr>
<td>$200,001 and up</td>
<td>128</td>
<td>8</td>
<td>10,618</td>
<td>76</td>
<td>24</td>
</tr>
<tr>
<td>Totals</td>
<td>2,669</td>
<td>60</td>
<td>15,168</td>
<td>41</td>
<td>59</td>
</tr>
</tbody>
</table>

---

*Median family income for the 2011–2012 MIT scholarship recipients is $82,389.
†Average scholarship package equals the average scholarship from any source (institutional, federal, state, and private) for MIT scholarship recipients only.
‡Family share of price is computed as the difference between each MIT scholarship recipient’s expense budget and their average scholarship package; it may differ from the calculated family contribution.
**Forms of Undergraduate Financial Aid**

The primary form of financial aid to MIT undergraduates is grants or scholarships—terms that are used interchangeably, although grants are gift aid based on need and scholarships are gift aid based on merit. The share of undergraduate financial aid in the form of grants/scholarships is steadily rising with MIT’s efforts to reduce student self-help (i.e. loan and job expectations). Since 2005–2006 the share of undergraduate aid in the form of grants/scholarships rose from 80.9 to 86.6 percent while the share in the form of student loans fell from 11.1 to 6.7 percent, and term-time work decreased from 8.0 to 6.7 percent.

From the students’ perspective, grants are the sole form of aid that unambiguously increases the financial accessibility of college, since they don’t require repayment and don’t increase the students’ indebtedness. The preponderance of grant aid at MIT sets the Institute apart from the national trend toward student loans as the primary form of undergraduate financial aid.

Over the last academic year, 22 percent of undergraduates borrowed $8.2 million in student loans from all sources. The average loan was $8,480. Student employment from on-campus jobs and Federal Work-Study Program positions (which include both on- and off-campus work) totaled $8.2 million, with 63 percent of undergraduates working and earning an average of $2,971 each.

### Types of Financial Aid for MIT Undergraduates 2011–2012

- **Grants and Scholarships**: 86%
- **Student Loans**: 7%
- **Term-time employment**: 7%

### Amounts of Financial Aid for MIT Undergraduates, 2011–2012

<table>
<thead>
<tr>
<th>Aid Type</th>
<th>Amount ($)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grants and Scholarships</td>
<td>105,467,161</td>
<td>86.6</td>
</tr>
<tr>
<td>Student Loans</td>
<td>8,217,126</td>
<td>6.7</td>
</tr>
<tr>
<td>Term-time employment</td>
<td>8,153,365</td>
<td>6.7</td>
</tr>
<tr>
<td>Total</td>
<td>121,837,652</td>
<td>100</td>
</tr>
</tbody>
</table>
Sources of Undergraduate Financial Aid
In 2011–2012, MIT provided 77.7 percent of undergraduate financial aid. The federal government provided 12.7 percent, and the remaining 9.6 percent came from state and private resources. MIT also differs here from the national trend of relying on the federal government as the largest source of financial aid.

MIT Financial Aid
Ninety-three percent of the financial aid that MIT provides comes in the form of grants. In 2011–2012, approximately 61 percent of MIT undergraduates received an MIT grant, averaging $32,917 each. These grants come primarily from MIT’s endowed funds, gifts from alumni and friends, and general Institute funds.

Federal Financial Aid
The U.S. Department of Education is the second-largest source of financial aid to MIT undergraduates. MIT participates in the Federal Pell Grant and the Federal Supplemental Educational Opportunity Grant, all of which provide need-based aid. Approximately 20 percent of MIT undergraduates receive Pell Grants. As of June 30th, 2011, the Academic Competitiveness Grant and the National Science and Mathematics Access to Retain Talent Grant Programs were eliminated.

MIT undergraduates also receive Robert C. Byrd Scholarships, the federally funded, state-administered grants which recognize exceptionally able high school seniors.

Forty percent of the federal aid that MIT undergraduates receive is in the form of loans. In 2011–2012, approximately 20 percent of MIT undergraduates received a federal loan, which averaged $7,118 each.

MIT is a lender under the Federal Perkins Loan Program, which provides subsidized student loans; and takes part in the Federal Direct Loan Program, which offers both subsidized and unsubsidized loans. It also participates in the Federal Work-Study Program, which provides student jobs, including paid community service positions. All of these programs are partnerships between the government and participating institutions, where institutions match the federal contributions with their own funds. MIT has participated in these programs since their inception and values their role in making an MIT education accessible to all qualified students.

In addition, MIT undergraduates receive federal aid for their participation in the Air Force, Army, and Navy ROTC. This aid is not based on need.

Private and State Financial Aid
Private sources of financial aid—including charitable and civic organizations, corporations, foundations, banks, and other financial institutions—are the third-largest source of financial aid to MIT undergraduates. This aid includes private grants and alternative student loans (so called to distinguish them from federal loans).

Students receive private scholarships in recognition of their academic accomplishments, athletic or musical skills, career interests, and many other criteria. Alternative loans ordinarily are unsubsidized and are based on the cost of education, less other financial awards, without any additional consideration for financial need.

Several states, in addition to Massachusetts, allow their residents to receive a state grant while attending MIT. These states include Connecticut, Delaware, Maine, New Hampshire, Pennsylvania, Rhode Island and Vermont. Most state grants are need-based. No state loan or employment programs are available to MIT undergraduates.
Sources of Financial Aid for MIT Undergraduates, 2011–2012

<table>
<thead>
<tr>
<th>Aid Source</th>
<th>Amount ($)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIT</td>
<td>94,632,625</td>
<td>77.7</td>
</tr>
<tr>
<td>Federal</td>
<td>15,524,612</td>
<td>12.7</td>
</tr>
<tr>
<td>State</td>
<td>214,812</td>
<td>0.2</td>
</tr>
<tr>
<td>Private</td>
<td>11,465,603</td>
<td>9.4</td>
</tr>
<tr>
<td>Total</td>
<td>121,837,652</td>
<td>100</td>
</tr>
</tbody>
</table>

The following chart summarizes the sources and types of financial aid MIT undergraduates received in 2011–2012.

Undergraduate Financial Aid, 2011–2012

<table>
<thead>
<tr>
<th>Source</th>
<th>Grants and Scholarships</th>
<th>Student Loans</th>
<th>Term-time Employment</th>
<th>Total*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Amount ($)</td>
<td>Students</td>
<td>Amount ($)</td>
<td>Students</td>
</tr>
<tr>
<td>MIT</td>
<td>87,856,306</td>
<td>2,669</td>
<td>201,400</td>
<td>68</td>
</tr>
<tr>
<td>Federal</td>
<td>7,767,350</td>
<td>1,036</td>
<td>6,178,816</td>
<td>868</td>
</tr>
<tr>
<td>State</td>
<td>214,812</td>
<td>115</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Private</td>
<td>9,628,693</td>
<td>1,280</td>
<td>1,836,910</td>
<td>95</td>
</tr>
<tr>
<td>Total*</td>
<td>105,467,161</td>
<td>3,238</td>
<td>8,217,126</td>
<td>969</td>
</tr>
</tbody>
</table>

*The total column and row are unduplicated numbers of students.
Graduate Financial Aid
Principles of MIT Graduate Financial Aid
MIT makes financial support available to graduate students from a variety of sources and in several different forms: fellowships; scholarships; traineeships; teaching and research assistantships; on-campus employment; and federal loans. Many forms of support are granted solely on the basis of merit, while others are granted on the basis of financial need or a combination of merit and need.

Tuition support, in particular, is provided to graduate and professional students in connection with research assistantships, teaching assistantships, and fellowship appointments. Tuition revenue support from MIT funds is considered financial aid but is not included in this report, as no singular office administers these sources of support.

A typical financial support package for a graduate student includes tuition, health insurance, and stipend support. The largest part of an MIT graduate student’s expenses ($41,770 for the 2012–2013 academic year) is dedicated to tuition. Another portion ($1,980) is dedicated to health insurance, unless a student already has comparable coverage. General living costs, including housing, food, transportation, and books, are largely covered by a stipend (approximately $30,888 for a doctoral student). MIT houses approximately 40% of the graduate student body on campus, which contributes to keeping average housing costs at a reasonable level for graduate students within the context of the Boston area. The graduate residences also help foster a thriving on-campus graduate community that many graduate students cite as one of the most positive aspects of their time here.

How Graduate Students are Supported
There is no cap on the number of graduate students admitted to MIT. Departments admit as many students as they can support based on their RA, TA, and fellowship resources as well as the number of faculty available to advise on research.
Forms of Graduate Financial Aid

**Fellowships, Traineeships, and Scholarships**

At MIT, fellowships and traineeships differ from scholarships. A fellowship award to a graduate student covers full or partial tuition, and also provides a stipend to help defray living expenses. In the context of graduate study, a scholarship covers full or partial tuition only. Although most awards are made on the basis of academic merit, financial need is a factor in some instances. Recipients must be enrolled as regular resident students. The Institute annually receives funds from individual and corporate donors for the support of fellowships and scholarships. In addition, government agencies and private foundations provide grants and fellowships—often directly to outstanding students—for use at institutions of the student’s choice. But occasionally these funds are directed to MIT for Institute designation of recipients.

**Teaching Assistantships**

MIT employs about 700 graduate students each year as part-time or full-time teaching assistants to assist the faculty in grading, instructing in the classroom and laboratory, and conducting tutorials. Teaching assistants receive stipends as well as tuition support for the services that they provide.

Appointments to teaching assistantships are made upon recommendation of the head of a department. Only full-time graduate students who are candidates for advanced degrees may be appointed, and the Free Application for Federal Student Aid (FAFSA) is required for all teaching assistants who are U.S. citizens or permanent residents.

**Research Assistantships**

Each year about 2,500 graduate students at MIT hold appointments as research assistants. The principal duty of a research assistant is to contribute to a program of departmental or interdepartmental research. Research assistants receive stipends as well as tuition support for the services that they provide, and are compensated on the basis of time devoted to their research.

Only full-time graduate students who are candidates for advanced degrees may be appointed. Students who receive financial support from other sources (fellowships, scholarships, etc.) may receive supplementary stipends as teaching or research assistants in accordance with Institute and departmental guidelines.

**Self-Support**

Graduate and professional students are eligible for need-based financial aid, including student loans as well as student employment under the Federal Work-Study Program, both of which are administered and reported by MIT Student Financial Services (SFS). Graduate student employment earnings under the Federal Work-Study Program, including on- and off-campus programs, totaled $2.2 million in 2011–2012, with 2.9 percent of graduate and professional students (184 students) earning $11,654 on average.

In AY2012, graduate students borrowed loans that totaled $43.2 million, an increase of approximately $1.7 million from the prior year, with 14.2 percent of graduate and professional students (901 students) borrowing an average of $47,997.
Section 3

Campus Research

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Research Support

MIT has historically viewed teaching and research as inseparable parts of its academic mission. Therefore, the Institute recognizes its obligation to encourage faculty to pursue research activities that hold the greatest promise for intellectual advancement. MIT maintains one of the most vigorous programs of research of any university and conducts basic and applied research principally at two Massachusetts locations, the MIT campus in Cambridge and MIT Lincoln Laboratory, a federally funded research and development center (FFRDC) in Lexington.

MIT pioneered the federal/university research relationship, starting in World War II. Initially called upon by the federal government to serve the national war effort, that relationship has continued into the present day, helping MIT fulfill its original mission of serving the nation and the world.

MIT Research Expenditures

Research Expenditures (MIT FY2012)

<table>
<thead>
<tr>
<th>Location</th>
<th>Expenditures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambridge campus</td>
<td>$681 million</td>
</tr>
<tr>
<td>Lincoln Laboratory*</td>
<td>$847 million</td>
</tr>
<tr>
<td>SMART*</td>
<td>$29 million</td>
</tr>
<tr>
<td>Total</td>
<td>$1.56 billion</td>
</tr>
</tbody>
</table>

*Totals do not include research performed by campus laboratories for Lincoln Laboratory and Singapore-MIT Alliance for Research and Technology (SMART).

All federal research on campus is awarded competitively based on the scientific and technical merit of the proposals. In FY2012, there were 2,540 active awards and 460 members of research consortia.

Research activities range from individual projects to large-scale, collaborative, and sometimes international endeavors. Peer-reviewed research accomplishments form a basis for reviewing the qualifications of prospective faculty appointees and for evaluations related to promotion and tenure decisions.

†SMART: Singapore-MIT Alliance for Research and Technology
‡Total Research constant dollars are calculated using the Consumer Price Index for all Urban Consumers weighted with fiscal year 2012 equaling 100.
The Institute provides the faculty with the infrastructure and support necessary to conduct research, much of it through contracts, grants, and other arrangements with government, industry, and foundations. The Office of Sponsored Programs provides central support related to the administration of sponsored research programs, and it assists faculty, other principal investigators, and their local administrators in managing and identifying resources for individual sponsored projects. In addition, a Research Council—which is chaired by the Vice President for Research and composed of the heads of all major research laboratories and centers that report to the Vice President for Research—addresses research policy and administration issues.

The Resource Development Office is available to work with faculty to generate proposals for foundation or other private support.

The Institute sees profound merit in a policy of open research and free interchange of information among scholars. At the same time, MIT is committed to acting responsibly and ethically in all its research activities. As a result, MIT has policies related to the suitability of research projects, research conduct, sources of support, use of human subjects, sponsored programs, relations with intelligence agencies, the acquisition of art and artifacts, the disposition of equipment, and collaborations with research-oriented industrial organizations. These policies are spelled out on the Policies and Procedures website and on the Office of Sponsored Programs website.

DAPER: Department of Athletics, Physical Education and Recreation
DSL: Division of Student Life
**Campus Research Sponsors**

The tables and charts for campus research expenditures below, and on the following pages, show the amount MIT expended by fiscal year (July 1–June 30). These figures do not include expenditures for MIT Lincoln Laboratory. Information for Lincoln Laboratory begins on page 66. Expenditures funded by industrial sponsors are shown on page 83 in the MIT and Industry section. Federal research expenditures include all primary contracts and grants, including sub-awards from other organizations where the federal government is the original funding source.

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### Campus Research Expenditures (in U.S. Dollars)

**Fiscal Years 2003–2012**

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Federal</th>
<th>Non-federal</th>
<th>Total</th>
<th>Federal</th>
<th>Non-federal</th>
<th>Total</th>
<th>Federal</th>
<th>Non-federal</th>
<th>Total</th>
<th>Federal</th>
<th>Non-federal</th>
<th>Total</th>
<th>Federal</th>
<th>Non-federal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>350,897,272</td>
<td>120,857,180</td>
<td>471,754,452</td>
<td>376,476,261</td>
<td>107,672,988</td>
<td>484,149,249</td>
<td>382,784,774</td>
<td>110,675,892</td>
<td>497,146,554</td>
<td>575,501,115</td>
<td>114,361,780</td>
<td>689,862,895</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>376,476,261</td>
<td>107,672,988</td>
<td>484,149,249</td>
<td>374,103,793</td>
<td>110,675,892</td>
<td>484,779,685</td>
<td>382,784,774</td>
<td>114,361,780</td>
<td>497,146,554</td>
<td>575,501,115</td>
<td>114,361,780</td>
<td>689,862,895</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>382,784,774</td>
<td>114,361,780</td>
<td>497,146,554</td>
<td>373,603,371</td>
<td>114,389,201</td>
<td>487,992,571</td>
<td>382,784,774</td>
<td>114,389,201</td>
<td>487,992,571</td>
<td>568,531,503</td>
<td>114,389,201</td>
<td>682,920,704</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2012 equaling 100.*
Campus Research Expenditures by Primary Sponsor

### FY2003

<table>
<thead>
<tr>
<th>Primary Sponsor</th>
<th>FY2003 (in U.S. Dollars)</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Defense</td>
<td>117,457,789</td>
<td>17</td>
</tr>
<tr>
<td>Department of Energy</td>
<td>90,940,035</td>
<td>13</td>
</tr>
<tr>
<td>Health and Human Services</td>
<td>133,687,332</td>
<td>20</td>
</tr>
<tr>
<td>NASA</td>
<td>30,203,575</td>
<td>4</td>
</tr>
<tr>
<td>National Science Foundation</td>
<td>81,487,208</td>
<td>12</td>
</tr>
<tr>
<td>All other federal</td>
<td>18,806,804</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total Federal</strong></td>
<td><strong>472,582,743</strong></td>
<td><strong>69</strong></td>
</tr>
<tr>
<td>Industry</td>
<td>109,744,829</td>
<td>16</td>
</tr>
<tr>
<td>Foundations and other nonprofits</td>
<td>48,373,460</td>
<td>7</td>
</tr>
<tr>
<td>State, local, and foreign governments</td>
<td>38,272,515</td>
<td>6</td>
</tr>
<tr>
<td>MIT internal</td>
<td>12,105,763</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total Non-Federal</strong></td>
<td><strong>208,496,567</strong></td>
<td><strong>31</strong></td>
</tr>
<tr>
<td>Campus Total</td>
<td>681,079,310</td>
<td>100</td>
</tr>
</tbody>
</table>
Department of Defense

Selected Projects

MIT “cheetah” robot rivals running animals in efficiency

A 70-pound “cheetah” robot designed by MIT researchers, including Sangbae Kim, may soon outpace its animal counterparts in running efficiency: In treadmill tests, the researchers have found that the robot—about the size and weight of an actual cheetah—wastes very little energy as it trots continuously for up to an hour and a half at 5 mph. The key to the robot’s streamlined stride: lightweight electric motors, set into its shoulders, that produce high torque with very little heat wasted.

To test the efficiency of the robot, the researchers ran it on a treadmill at a steady 5 mph clip. They measured the voltage and current of the battery, as well as that from each motor. They calculated the robot’s efficiency of locomotion—also known as cost of transport—and found that it was more efficient than robotic competitors such as Boston Dynamic’s Big Dog and Honda’s two-legged robot, ASIMO.

Currently, the team is assembling a set of new motors, designed by Jeffrey Lang. Kim expects that once the group outfits the robot with improved motors, the cheetah robot will be able to gallop at speeds of up to 35 mph. The research was funded by the Defense Advanced Research Projects Agency’s Maximum Mobility and Manipulation (M3) program.

One-two punch knocks out aggressive breast cancer cells

Doctors have long known that treating patients with multiple cancer drugs often produces better results than treatment with just a single drug. Now, a study shows that the order and timing of drug administration can have a dramatic effect. Researchers, led by Michael Yaffe who is a member of the David H. Koch Institute for Integrative Cancer Research at MIT, are now working with researchers at Dana-Farber Cancer Institute to plan clinical trials of the staggered drug therapy. Both drugs—erlotinib and doxorubicin—are already approved for cancer treatment.

In a paper, published in Cell, the researchers showed that staggering the doses of two specific drugs dramatically boosts their ability to kill a particularly malignant type of breast cancer cells. Postdoc Michael Lee was lead author of the paper.

The research was funded by the National Institutes of Health Integrative Cancer Biology Program and the Department of Defense.

Decoding the structure of bone

The bones that support our bodies are made of remarkably complex arrangements of materials—so much so that decoding the precise structure responsible for their great strength and resilience has eluded scientists’ best efforts for decades. A team of researchers, led by Markus Buehler, have finally unraveled the structure of bone with almost atom-by-atom precision, after many years of analysis by some of the world’s most powerful computers and comparison with laboratory experiments to confirm the computed results.

Buehler says the riddle was to find how two different materials—a soft, flexible biomolecule called collagen and a hard, brittle form of the mineral apatite—combine to form something that is simultaneously hard, tough and slightly flexible. One key they found, is that the hydroxyapatite grains are tiny, thin platelets deeply embedded in the collagen matrix. The two constituents are bound together by electrostatic interactions, which allow them to slip somewhat against each other without breaking. Ultimately, this work could lead to the synthesis of new bone-like materials, either as biomedical materials to substitute for bone or as new structural materials for engineering uses.

Postdoc Arun Nair was the first author of the paper, with graduate student Shu-Wei Chang, postdoc Alfonso Gautieri, and Markus Buehler.

The work was supported by the Office of Naval Research, the Army Research Office, the National Science Foundation, and the MIT-Italy Program. The research used high-performance computing resources from NSF’s XSEDE program, the CILEA Consortium, the LISA Initiative, and the ISCRA Initiative.
Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2012
(shown in descending order of expenditures)

Research Laboratory of Electronics
Computer Science and Artificial Intelligence Laboratory
Institute for Soldier Nanotechnologies
Microsystems Technology Laboratories
Mechanical Engineering
Aeronautics and Astronautics
Plasma Science and Fusion Center
Laboratory for Information and Decision Systems
Media Laboratory
McGovern Institute for Brain Research

In fall 2012, the Department of Defense funded the primary appointments of graduate students with 338 research assistantships and 84 fellowships.

Twenty-eight current faculty and staff have received the Office of Naval Research Young Investigator Program Award.

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2012 equaling 100.
**Department of Energy**  
*Selected Projects*

**One order of steel; hold the greenhouse gases**  
Anyone who has seen pictures of the giant, red-hot cauldrons in which steel is made—fed by vast amounts of carbon, and belching flame and smoke—would not be surprised to learn that steelmaking is one of the world’s leading industrial sources of greenhouse gases. But remarkably, a new process developed by MIT researchers could change all that.

The new process even carries a couple of nice side benefits: The resulting steel should be of higher purity, and eventually, once the process is scaled up, cheaper. Donald Sadoway, senior author of a new paper describing the process, says this could be a significant “win, win, win” proposition. The paper, co-authored by Antoine Allanore, and former postdoc Lan Yin, has been published in the journal *Nature*.

The idea for the new method, Sadoway says, arose when he received a grant from NASA to look for ways of producing oxygen on the moon—a key step toward future lunar bases. Sadoway found that a process called molten oxide electrolysis could use iron oxide from the lunar soil to make oxygen in abundance, with no special chemistry. He tested the process using lunar-like soil from Meteor Crater in Arizona finding that it produced steel as a by-product.

The research was supported by the American Iron and Steel Institute and the U.S. Department of Energy.


**‘Invisibility’ could be a key to better electronics**  
A new approach that allows objects to become “invisible” has now been applied to an entirely different area: letting particles “hide” from passing electrons, which could lead to more efficient thermoelectric devices and new kinds of electronics.

The concept—developed by graduate student Bolin Liao, former postdoc Mona Zebarjadi, research scientist Keivan Esfarjani, and Gang Chen—is described in a paper in the journal *Physical Review Letters*. The researchers’ initial impetus was to optimize the materials used in thermoelectric devices, which produce an electrical current from a temperature gradient. Such devices require a combination of characteristics that are hard to obtain: high electrical conductivity (so the generated current can flow freely), but low thermal conductivity (to maintain a temperature gradient). The team’s simulations show this electron-cloaking material could meet these requirements unusually well.

This research was funded by the U.S. Department of Energy through MIT’s Solid-State Solar-Thermal Energy Conversion center, a DoE Energy Frontier Research Center.

http://web.mit.edu/newsoffice/2012/invisibility-core-shell-nanoparticles-1012.html

**MIT researchers discover a new kind of magnetism**  
Following up on earlier theoretical predictions, MIT researchers have now demonstrated experimentally the existence of a fundamentally new kind of magnetic behavior, adding to the two previously known states of magnetism.

Ferromagnetism is the simple magnetism of a bar magnet or compass needle. In a second type of magnetism, antiferromagnetism, the magnetic fields of the ions within a metal or alloy cancel each other out. The prediction and discovery of antiferromagnetism won Nobel Prizes for French physicist Louis Neel in 1970 and for Clifford Shull in 1994.

The experimental work showing the existence of this new state, called a quantum spin liquid (QSL), is reported in the journal *Nature*, with Young Lee as the senior author and Tianheng Han PhD 2012, as lead author. The QSL is a solid crystal, but its magnetic state is described as liquid: Unlike the other two kinds of magnetism, the magnetic orientations of the individual particles within it fluctuate constantly, resembling the constant motion of molecules within a true liquid.

In addition to Lee and Han, the work was carried out by J.S. Helton of NIST, research scientist Shaoyan Chu, Daniel Nocera, Jose Rodriguez-Rivera of NIST and the University of Maryland, and Colin Broholm of Johns Hopkins University.

The work was supported by the U.S. Department of Energy and the National Science Foundation.


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Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2012
(shown in descending order of expenditures)

- Plasma Science and Fusion Center
- Laboratory for Nuclear Science
- Materials Processing Center
- Research Laboratory of Electronics
- Nuclear Science and Engineering
- Mechanical Engineering
- Chemical Engineering
- Materials Science and Engineering
- Nuclear Reactor Laboratory
- Center for Global Change Science

In fall 2012, the Department of Energy funded the primary appointments of graduate students with 232 research assistantships, two teaching assistantships, and 23 fellowships.

Twenty-two current faculty have received the Department of Energy Outstanding Junior Investigator award or Early Career Research Program Award.

<table>
<thead>
<tr>
<th>Department</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campus research</td>
<td>65,610,631</td>
<td>65,773,294</td>
<td>73,273,733</td>
<td>89,562,126</td>
<td>90,940,035</td>
</tr>
<tr>
<td>Constant dollars*</td>
<td>70,526,755</td>
<td>69,728,128</td>
<td>76,935,023</td>
<td>92,186,186</td>
<td>90,940,035</td>
</tr>
</tbody>
</table>

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2012 equaling 100.
MIT team builds most complex synthetic biology circuit yet
Using genes as interchangeable parts, synthetic biologists design cellular circuits that can perform new functions, such as sensing environmental conditions. However, the complexity that can be achieved in such circuits has been limited by a critical bottleneck: the difficulty in assembling genetic components that don’t interfere with each other.

Unlike electronic circuits on a silicon chip, biological circuits inside a cell cannot be physically isolated from one another. Christopher Voigt and his students have now developed circuit components that don’t interfere with one another, allowing them to produce the most complex synthetic circuit ever built. The circuit, described in Nature, integrates four sensors for different molecules. Such circuits could be used in cells to precisely monitor their environments and respond appropriately.

Lead author of the paper is former postdoc Tae Seok Moon, now an assistant professor at Washington University in St. Louis. Other authors are postdocs Chunbo Lou and Brynne Stanton, and University of California at San Francisco graduate student Alvin Tamsir.

The research was funded by the U.S. Office of Naval Research, the National Institutes of Health, Life Technologies, Defense Advanced Research Projects Agency and the National Science Foundation.


New material harvests energy from water vapor
MIT engineers have created a new polymer film that can generate electricity by drawing on a ubiquitous source: water vapor. The new material changes its shape after absorbing tiny amounts of evaporated water, allowing it to repeatedly curl up and down. Harnessing this continuous motion could drive robotic limbs or generate enough electricity to power micro- and nanoelectronic devices, such as environmental sensors.

Mingming Ma, a postdoc at MIT’s David H. Koch Institute for Integrative Cancer Research, is lead author of a paper describing the new material in Science.


Engineering cells for more efficient biofuel production
In the search for renewable alternatives to gasoline, heavy alcohols such as isobutanol are promising candidates. Not only do they contain more energy than ethanol, but they are also more compatible with existing gasoline-based infrastructure. For isobutanol to become practical, however, scientists need a way to reliably produce huge quantities of it from renewable sources. MIT chemical engineers and biologists have now devised a way to dramatically boost isobutanol production in yeast, which naturally make it in small amounts. They engineered yeast so that isobutanol synthesis takes place entirely within mitochondria, cell structures that generate energy and also host many biosynthetic pathways. Using this approach, they were able to boost isobutanol production by about 260 percent.

Though still short of the scale needed for industrial production, the advance suggests that this is a promising approach to engineering not only isobutanol but other useful chemicals as well, says Gregory Stephanopoulos, one of the senior authors of a paper describing the work in Nature Biotechnology.

Stephanopoulos collaborated with Professor Gerald Fink, member of the Whitehead Institute, on this research. The lead author of the paper is Jose Avalos, a postdoc at the Whitehead Institute and MIT.

The research was funded by the National Institutes of Health and Shell Global Solutions.

### Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2012

(Shown in descending order of expenditures)

<table>
<thead>
<tr>
<th>Department/Program</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koch Institute for Integrative Cancer Research Biology</td>
<td>113,348,419</td>
<td>116,960,155</td>
<td>136,923,238</td>
<td>152,664,013</td>
<td>133,687,332</td>
</tr>
<tr>
<td>Chemistry</td>
<td>112,958,244</td>
<td>138,935,579</td>
<td>7,637,672</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Biological Engineering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvard/MIT Division of Health Sciences and Technology</td>
<td>226,306,663</td>
<td>255,895,734</td>
<td>144,560,910</td>
<td>152,664,013</td>
<td>133,687,332</td>
</tr>
<tr>
<td>Center for Environmental Health Sciences</td>
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<tr>
<td>Picower Institute for Learning and Memory</td>
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<tr>
<td>McGovern Institute for Brain Research</td>
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<td></td>
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</tr>
<tr>
<td>Computer Science and Artificial Intelligence Laboratory</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Research Laboratory of Electronics</td>
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</tr>
</tbody>
</table>

*The Broad Institute separated from MIT on July 1, 2009 and no longer receives funding through MIT. The chart above displays both MIT campus research expenditures and Broad Institute research expenditures funded through MIT.

†Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2012 equaling 100.

In fall 2012, the Department of Health and Human Services, including the National Institutes of Health, funded the primary appointments of graduate students with 151 research assistantships and 101 fellowships.

Nine current faculty have received the NIH Director’s Pioneer Award. The recipients are Emery Brown, Arup Chakraborty, Hidde Ploegh, Aviv Regev, Leona Samson, Alice Ting, Alexander van Oudenaarden, Mehmet Yanik, and Feng Zhang.
Scientists discover water ice on Mercury

Mercury, the smallest and innermost planet in our solar system, revolves around the sun in a mere 88 days, making a tight orbit that keeps the planet incredibly toasty. Surface temperatures on Mercury can reach a blistering 800 degrees Fahrenheit—hot enough to liquefy lead. Researchers from NASA, MIT, the University of California at Los Angeles and elsewhere have discovered evidence that the scorching planet may harbor pockets of water ice, along with organic material, in several permanently shadowed craters near Mercury's north pole.

“We thought the most exciting finding could be that this really was water ice,” says Maria Zuber, a member of the research team. “But the identification of darker, insulating material that may indicate complex organics makes the story even more thrilling.”

To get a clearer picture of Mercury’s polar regions, Zuber and her colleagues analyzed observations taken by NASA’s MESSENGER (MErcury Surface, Space ENvironment, GEochemistry and Ranging) mission, a probe that has been orbiting the planet and mapping its topography since April 2011. MESSENGER will continue to orbit Mercury, and Zuber says future data may reveal information beyond the planet’s surface. “There are still some really good questions to answer about the interior,” Zuber says. “I’ll tell you, we’re not done.”


GRAIL reveals a battered lunar history

Beneath its heavily pockmarked surface, the moon’s interior bears remnants of the very early solar system. Unlike Earth, where plate tectonics has essentially erased any trace of the planet’s earliest composition, the moon’s interior has remained relatively undisturbed over billions of years, preserving a record in its rocks of processes that occurred in the solar system’s earliest days.

Now scientists at MIT, NASA, the Jet Propulsion Laboratory and elsewhere have found evidence that, beneath its surface, the moon’s crust is almost completely pulverized. The finding suggests that, in its first billion years, the moon—and probably other planets like Earth—may have endured much more fracturing from massive impacts than previously thought.

The startling observations come from data collected by NASA’s Gravity Recovery and Interior Laboratory (GRAIL) mission. From GRAIL’s measurements, planetary scientists have now stitched together a high-resolution map of the moon’s gravity—a force created by surface structures such as mountains and craters, as well as deeper structures below the surface. The resulting map reveals an interior gravitational field consistent with an incredibly fractured lunar crust. Maria Zuber leads the GRAIL mission.


NASA selects MIT-led TESS project for 2017 mission

Following a three-year competition, NASA has selected the Transiting Exoplanet Survey Satellite (TESS) project at MIT for a planned launch in 2017. The space agency announced the mission—to be funded by a $200 million grant to the MIT-led team—in April 2013.

TESS team partners include the MIT Kavli Institute for Astrophysics and Space Research (MKI) and MIT Lincoln Laboratory; NASA’s Goddard Spaceflight Center; Orbital Sciences Corporation; NASA’s Ames Research Center; the Harvard-Smithsonian Center for Astrophysics; The Aerospace Corporation; and the Space Telescope Science Institute.

The project, led by principal investigator George Ricker, a senior research scientist at MKI, will use an array of wide-field cameras to perform an all-sky survey to discover transiting exoplanets, ranging from Earth-sized planets to gas giants, in orbit around the brightest stars in the sun’s neighborhood.

NASA Campus Research Expenditures (in U.S. Dollars)
Fiscal Years 2008–2012

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campus research</td>
<td>25,479,571</td>
<td>27,358,036</td>
<td>30,629,006</td>
<td>28,079,693</td>
<td>30,203,575</td>
</tr>
<tr>
<td>Constant dollars*</td>
<td>27,388,724</td>
<td>29,003,028</td>
<td>32,159,455</td>
<td>28,902,394</td>
<td>30,203,575</td>
</tr>
</tbody>
</table>

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2012 equaling 100.

In fall 2012, NASA funded the primary appointments of graduate students with 60 research assistantships and 12 fellowships.

Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2012
(shown in descending order of expenditures)

Kavli Institute for Astrophysics and Space Research
Earth, Atmospheric, and Planetary Sciences
Aeronautics and Astronautics
Earth System Initiative
Haystack Observatory
Center for Global Change Science
Research Laboratory of Electronics
Harvard/MIT Division of Health Sciences and Technology
Mechanical Engineering
Institute for Soldier Nanotechnologies
National Science Foundation
Selected Projects

Funneling the sun’s energy
The quest to harness a broader spectrum of sunlight’s energy to produce electricity has taken a radically new turn with the proposal of a “solar energy funnel” that takes advantage of materials under elastic strain. Ju Li is a corresponding author of a paper describing the new solar-funnel concept that was published in the journal Nature Photonics.

In this case, the “funnel” is a metaphor: Electrons and their counterparts, holes—which are split off from atoms by the energy of photons—are driven to the center of the structure by electronic forces, not by gravity. As it happens, the material actually does assume the shape of a funnel: It is a stretched sheet of vanishingly thin material, poked down at its center by a microscopic needle that indents the surface and produces a curved, funnel-like shape. The pressure exerted by the needle imparts elastic strain, which increases toward the sheet’s center. The varying strain changes the atomic structure just enough to “tune” different sections to different wavelengths of light—including not just visible light, but also some of the invisible spectrum, which accounts for much of sunlight’s energy.

The work was done with Ji Feng of Peking University and Cheng-Wei Huang, and was supported by the U.S. National Science Foundation, the U.S. Air Force Office of Scientific Research, and the National Natural Science Foundation of China.


MIT researchers improve quantum dot performance
Quantum dots—tiny particles that emit light in a dazzling array of glowing colors—have the potential for many applications, but have faced a series of hurdles to improved performance. First discovered in the 1980s, these materials have been the focus of intense research because of their potential to provide significant advantages in a wide variety of optical applications, but their actual usage has been limited by several factors. Research published in the journal Nature Materials by postdoc Ou Chen, Moungi Bawendi, and several others raises the prospect that these limiting factors can all be overcome.

Moreover, where previous schemes required sandwiching the storage molecules between two ferromagnetic electrodes, the new scheme would require only one ferromagnetic electrode. That could greatly simplify manufacture.

The research was funded by the Office of Naval Research and by the National Science Foundation.


Storing data in individual molecules
In 1980, a hard drive could store about a half-mega-byte of data in a square inch of disk space; now, manufacturers are closing in on a million megabytes of data per square inch. An experimental technology called molecular memory, which would store data in individual molecules, promises another 1,000-fold increase in storage density. In Nature, an international team of researchers led by senior research scientist Jagadeesh Moodera, describes a new molecular-memory scheme.

In addition to Chen and Bawendi, the team included seven other students and postdocs and two researchers from Massachusetts General Hospital and Harvard Medical School. The work was supported by the National Institutes of Health, the Army Research Office through MIT’s Institute for Soldier Nanotechnologies, and by the National Science Foundation through the Collaborative Research in Chemistry Program.

Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2012
(shown in descending order of expenditures)

- Computer Science and Artificial Intelligence Laboratory
- Earth, Atmospheric, and Planetary Sciences Research Laboratory of Electronics
- Biological Engineering
- Kavli Institute for Astrophysics and Space Research
- Mathematics
- Haystack Observatory
- Chemistry
- Mechanical Engineering
- Center for Materials Science and Engineering

In fall 2012, the National Science Foundation funded the primary appointments of graduate students with 281 research assistantships and 299 fellowships.

The National Science Foundation has awarded Faculty Early Career Development (CAREER) Awards to 138 current faculty and staff members.

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2012 equaling 100.
Other Federal Agencies
Selected Projects

MIT selected by U.S. Department of Transportation to lead New England Consortium on Transportation Safety & Livable Communities

The Engineering Systems Division’s Center for Transportation & Logistics has been selected to lead the U.S. Department of Transportation Research & Innovative Technology Administration University Transportation Center for the New England Region. The University Transportation Centers Program (UTC) strives to advance research and education programs that address critical transportation challenges facing our nation. The UTCs, which are located throughout the United States, conduct research that directly supports the priorities of the U.S. Department of Transportation, and the participating universities are a critical part of the nation’s transportation strategy.

The two-year $3.5 million grant funds transportation and education programs at MIT and its regional partners that include the University of Connecticut, Harvard University, and the Universities of Maine and Massachusetts. Joseph Coughlin led the proposal and is principal investigator of the grant establishing the New England University Transportation Center. The grant will support surface transportation research and education projects in the area of safety and livable communities with special attention given to the role of new technologies and disadvantaged populations such as the elderly.


Study: At most a third of us show a consistent approach to financial risk

In economics, classical theory holds that we have consistent risk preferences, regardless of the precise decision, from investments to insurance programs and retirement plans. But studies in behavioral economics indicate that people’s choices can vary greatly depending on the subject matter and circumstances of each decision.

Now a new paper co-authored by Amy Finkelstein brings a large dose of empirical data to the problem, by looking at the way tens of thousands of Americans have handled risk in selecting health insurance and retirement plans. The study, published in the American Economic Review, finds that at most 30 percent of us make consistent decisions about financial risk across a variety of areas.

Finkelstein suggests the study can be useful for social scientists or policymakers who build models or construct programs that make assumptions about risk tolerance; now those models can include more specific estimates of the ways people bear risk.

Research for the current paper was funded by the National Institute of Aging, the National Science Foundation, the U.S. Social Security Administration, the Sloan Foundation, and the MacArthur Foundation.

Some of the leading other federal agencies providing funding include: Federal Aviation Administration, Intelligence Advanced Research Projects Activity, Department of Transportation, Department of Commerce, Department of Homeland Security, and Environmental Protection Agency.

Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2012
(shown in descending order of expenditures)

Aeronautics and Astronautics
Center for Transportation and Logistics
Computer Science and Artificial Intelligence Laboratory
Sea Grant College Program
Center for Global Change Science
Earth, Atmospheric and Planetary Sciences
Civil and Environmental Engineering Research Laboratory of Electronics
Sloan School of Management
Materials Processing Center

In fall 2012, Other Federal Agencies funded the primary appointments of graduate students with 47 research assistantships and six fellowships.
Nonprofit Organizations
Selected Projects

Editing the genome with high precision
Researchers at MIT, the Broad Institute, and Rockefeller University have developed a new technique for precisely altering the genomes of living cells by adding or deleting genes. The researchers say the technology could offer an easy-to-use, less-expensive way to engineer organisms that produce biofuels; to design animal models to study human disease; and to develop new therapies, among other potential applications.

To create their new genome-editing technique, the researchers modified a set of bacterial proteins that normally defend against viral invaders. Using this system, scientists can alter several genome sites simultaneously and can achieve much greater control over where new genes are inserted, says Feng Zhang, leader of the research team.

The research was funded by the National Institute of Mental Health; the W.M. Keck Foundation; the McKnight Foundation; the Bill & Melinda Gates Foundation; the Damon Runyon Cancer Research Foundation; the Searle Scholars Program; and philanthropic support from MIT alumni Mike Boylan and Bob Metcalfe, as well as the newscaster Jane Pauley.


Stacking 2-D materials produces surprising results
Graphene has dazzled scientists, ever since its discovery more than a decade ago, with its unequalled electronic properties, its strength and its light weight. But one long-sought goal has proved elusive: how to engineer into graphene a property called a band gap, which would be necessary to use the material to make transistors and other electronic devices.

New findings by researchers at MIT are a major step toward making graphene with this coveted property. The work could also lead to revisions in some theoretical predictions in graphene physics. The new technique involves placing a sheet of graphene—a carbon-based material whose structure is just one atom thick—on top of hexagonal boron nitride, another one-atom-thick material with similar properties. The resulting material shares graphene’s amazing ability to conduct electrons, while adding the band gap necessary to form transistors and other semiconductor devices.

The work was funded by the U.S. Department of Energy, the Gordon and Betty Moore Foundation and the National Science Foundation.


Exploring a breakdown in communication
One of the defining characteristics of autism is difficulty communicating with others. However, it is unclear whether those struggles arise only from the poor social skills commonly associated with autism, or whether autistic children suffer from more specific linguistic impairments. In a study appearing in the journal Language Acquisition, Kenneth Wexler reports that some autistic children do have a specific linguistic deficit: They are unable to understand a specific type of grammatical construction involving reflexive pronouns. This finding suggests that there may be a biological basis for the language impairments seen in autism, and paves the way for genetic studies that could reveal new targets for treating the disease, Wexler says.

Nonprofit Organizations Campus and Broad Institute Research Expenditures (in U.S. Dollars)*
Fiscal Years 2008–2012

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campus research</td>
<td>28,324,003</td>
<td>37,161,950</td>
<td>46,846,106</td>
<td>44,436,470</td>
<td>48,373,460</td>
</tr>
<tr>
<td>Broad Institute research</td>
<td>19,370,397</td>
<td>23,376,207</td>
<td>3,792,875</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total Nonprofit</td>
<td>47,694,400</td>
<td>60,538,156</td>
<td>50,638,981</td>
<td>44,436,470</td>
<td>48,373,460</td>
</tr>
<tr>
<td>Constant dollars†</td>
<td>51,268,083</td>
<td>64,178,211</td>
<td>53,169,274</td>
<td>45,738,404</td>
<td>48,373,460</td>
</tr>
</tbody>
</table>

*The Broad Institute separated from MIT on July 1, 2009 and no longer receives funding through MIT. The chart above displays both MIT campus research expenditures and Broad Institute research expenditures funded through MIT.
†Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2012 equaling 100.

Leading Departments, Laboratories, and Centers
Receiving Support in Fiscal Year 2012
(shown in descending order of expenditures)

Masdar Institute of Science and Technology
Mechanical Engineering
Economics
McGovern Institute for Brain Research
Brain and Cognitive Sciences
MIT-Singapore University of Technology and Design Collaboration
Civil and Environmental Engineering
MIT Energy Initiative
Earth System Initiative
Koch Institute for Integrative Cancer Research
Broad Institute of Harvard and MIT

The Broad Institute is founded on two principles—that this generation has a historic opportunity and responsibility to transform medicine, and that to fulfill this mission, we need new kinds of research institutions with a deeply collaborative spirit across disciplines and organizations. Operating under these principles, the Broad Institute is committed to meeting the most critical challenges in biology and medicine.

Broad scientists pursue a wide variety of projects that cut across scientific disciplines and institutions. Collectively, these projects aim to: assemble a complete picture of the molecular components of life; define the biological circuits that underlie cellular responses; uncover the molecular basis of major inherited diseases; unearth all the mutations that underlie different cancer types; discover the molecular basis of major infectious diseases; and transform the process of therapeutic discovery and development.

MIT administered Broad Institute research expenditures during FY2004–FY2010. The Broad Institute separated from MIT on July 1, 2009. The chart below displays Broad Institute research expenditures funded through MIT. Five MIT faculty members are currently core members of the Broad Institute. Their research expenditures are not reflected in the campus research expenditures totals found in the rest of this section.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Health and Human Services</td>
<td>46,344,769</td>
<td>71,220,070</td>
<td>78,238,123</td>
<td>87,315,284</td>
<td>112,958,244</td>
<td>138,935,579</td>
<td>7,637,672</td>
</tr>
<tr>
<td>National Science Foundation</td>
<td>1,304,105</td>
<td>1,809,782</td>
<td>1,416,267</td>
<td>2,107,756</td>
<td>1,022,548</td>
<td>990,917</td>
<td>(772)</td>
</tr>
<tr>
<td>All other federal</td>
<td>33,683</td>
<td>464,691</td>
<td>1,912,009</td>
<td>2,377,190</td>
<td>919,377</td>
<td>1,113,471</td>
<td>79,716</td>
</tr>
<tr>
<td>Industry</td>
<td>514,186</td>
<td>3,200,233</td>
<td>5,944,244</td>
<td>11,242,651</td>
<td>6,935,104</td>
<td>13,656,981</td>
<td>680,132</td>
</tr>
<tr>
<td>Nonprofit organizations</td>
<td>425,355</td>
<td>1,432,595</td>
<td>2,694,886</td>
<td>7,683,458</td>
<td>19,370,397</td>
<td>23,376,207</td>
<td>3,792,875</td>
</tr>
<tr>
<td>MIT internal</td>
<td>(3,317,186)</td>
<td>4,516,525</td>
<td>143,822</td>
<td>549,160</td>
<td>341,683</td>
<td>74,792</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>45,304,913</strong></td>
<td><strong>82,643,895</strong></td>
<td><strong>90,349,350</strong></td>
<td><strong>110,275,500</strong></td>
<td><strong>141,547,351</strong></td>
<td><strong>178,147,946</strong></td>
<td><strong>12,189,623</strong></td>
</tr>
<tr>
<td>Constant dollars†</td>
<td>55,401,735</td>
<td>98,109,832</td>
<td>103,322,554</td>
<td>122,930,748</td>
<td>152,153,320</td>
<td>188,859,674</td>
<td>12,798,706</td>
</tr>
</tbody>
</table>

*The Broad Institute separated from MIT on July 1, 2009 and no longer receives funding through MIT.
† Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2012 equaling 100.
MIT and the American Recovery and Reinvestment Act

The 2009 economic stimulus package, the American Recovery and Reinvestment Act (ARRA), provided support for science funding at a time when universities nationwide were facing funding cutbacks and financial concerns due to the recession. Overall, ARRA provided $22 billion in one-time research and development (R&D) funding for fiscal years 2009 (FY2009) and 2010 (FY2010), in addition to regularly appropriated funds. This funding was included in the legislation to help fulfill its purpose of “reinvestment”; since R&D support is directly related to the nation’s innovation capacity and therefore its longer term economic strength, the Congress allocated approximately two percent of the total funding in the legislation to R&D.

In most cases, ARRA R&D funding was applied toward existing research proposals that had received high ratings within agencies but had not been awarded due to funding limitations. In some cases, however, ARRA funding was applied toward new initiatives. For example at DoE, ARRA included the initial funding ($400 million) for the new Advanced Research Projects Agency-Energy (ARPA-E) and full five-year funding for additional Energy Frontier Research Centers (EFRCs). MIT has received several ARPA-E awards to date, and houses two EFRCs, one of which is funded through ARRA.

MIT’s total ARRA expenditures through the 3rd quarter of fiscal year 2013 ending March 31, 2013 total $138,060,960.

For the quarter January 1, 2013–March 31, 2013, MIT reported that 111.89 jobs were created or retained with ARRA funding.

<table>
<thead>
<tr>
<th>Original source of funding</th>
<th>Number of awards</th>
<th>Obligated amount (in U.S. dollars)</th>
<th>Total expenditures (in U.S. dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department of Energy</td>
<td>27</td>
<td>53,867,333</td>
<td>43,311,690</td>
</tr>
<tr>
<td>Health and Human Services/National Institutes of Health</td>
<td>91</td>
<td>63,252,892</td>
<td>62,185,134</td>
</tr>
<tr>
<td>National Science Foundation</td>
<td>62</td>
<td>30,818,602</td>
<td>29,379,260</td>
</tr>
<tr>
<td>NASA</td>
<td>3</td>
<td>885,212</td>
<td>885,212</td>
</tr>
<tr>
<td>All other agencies</td>
<td>7</td>
<td>2,644,100</td>
<td>2,299,664</td>
</tr>
</tbody>
</table>
Section 4
Lincoln Laboratory

Research Expenditures  
Authorized Funding  
Lincoln Laboratory’s Economic Impact  
Air and Missile Defense Technology  
Communications Systems  
Cyber Security and Information Sciences  
Intelligence, Surveillance, and Reconnaissance Systems and Technology  
Space Control  
Advanced Technology  
Tactical Systems  
Homeland Protection  
Lincoln Laboratory Staffing  
Test Facilities and Field Sites
Lincoln Laboratory

MIT Lincoln Laboratory is a federally funded research and development center (FFRDC) operated by the Institute under contract with the Department of Defense. The Laboratory’s core competencies are in sensors, information extraction (signal processing and embedded computing), communications, integrated sensing, and decision support, all supported by a strong program in advanced electronics technology.

Since its establishment in 1951, MIT Lincoln Laboratory’s mission has been to apply technology to problems of national security. The Laboratory’s technology development is focused on its primary mission areas—space control; air and missile defense technology; communication systems; cyber security and information sciences; intelligence, surveillance, and reconnaissance systems and technology; advanced technologies; tactical systems; and homeland protection. In addition, Lincoln Laboratory undertakes government-sponsored, nondefense projects in areas such as air traffic control and weather surveillance.

Two of the Laboratory’s principal technical objectives are (1) the development of components and systems for experiments, engineering measurements, and tests under field operating conditions and (2) the dissemination of information to the government, academia, and industry. Program activities extend from fundamental investigations through the design process, and finally to field demonstrations of prototype systems. Emphasis is placed on transitioning systems and technology to industry.

MIT Lincoln Laboratory also emphasizes meeting the government’s FFRDC goals of maintaining long-term competency, retaining high-quality staff, providing independent perspective on critical issues, sustaining strategic sponsor relationships, and developing technology for both long-term interests and short-term, high-priority needs.

Authorized Funding by Sponsor FY2012*
Total Authorized Funding = $940.9 million

DARPA: Defense Advanced Research Projects Agency
DHS: Department of Homeland Security
DoD: Department of Defense
FAA: Federal Aviation Administration
MDA: Missile Defense Agency
NASA: National Aeronautics and Space Administration
NOAA: National Oceanic and Atmospheric Administration
OSD: Office of the Secretary of Defense

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30.
Research Expenditures
MIT Fiscal Years 2008–2012*

*Research expenditure data are for the MIT fiscal year, July 1–June 30.

Authorized Funding
Fiscal Years 2008–2012†

†Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30.
Lincoln Laboratory’s Economic Impact

Lincoln Laboratory has generated and supported a range of national business and industrial activities. The charts below show the Laboratory’s economic impact by business category and state. In FY2012, the Laboratory issued subcontracts with a value that exceeded $440 million; New England states are the primary beneficiaries of the outside procurement program.

**Goods and Services Expenditures by Type Fiscal Year 2012** (in $millions)

<table>
<thead>
<tr>
<th>Type</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large business</td>
<td>208.7</td>
</tr>
<tr>
<td>Woman-owned small business</td>
<td>82.9</td>
</tr>
<tr>
<td>Veteran-owned small business</td>
<td>27.9</td>
</tr>
<tr>
<td>Small disadvantaged business</td>
<td>9.1</td>
</tr>
<tr>
<td>All other small business</td>
<td>114.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>442.9</strong></td>
</tr>
</tbody>
</table>

**Top Seven States**

<table>
<thead>
<tr>
<th>State</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massachusetts†</td>
<td>186.4</td>
</tr>
<tr>
<td>California</td>
<td>51.5</td>
</tr>
<tr>
<td>Colorado</td>
<td>37.1</td>
</tr>
<tr>
<td>New Hampshire</td>
<td>25.2</td>
</tr>
<tr>
<td>Texas</td>
<td>22.1</td>
</tr>
<tr>
<td>Virginia</td>
<td>18.2</td>
</tr>
<tr>
<td>Arizona</td>
<td>15.4</td>
</tr>
</tbody>
</table>

**Other New England States**

<table>
<thead>
<tr>
<th>State</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connecticut</td>
<td>6.4</td>
</tr>
<tr>
<td>Vermont</td>
<td>0.4</td>
</tr>
<tr>
<td>Maine</td>
<td>0.2</td>
</tr>
<tr>
<td>Rhode Island</td>
<td>0.0</td>
</tr>
</tbody>
</table>

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30
†Does not include orders to MIT ($9.3 million)
Air and Missile Defense Technology
In the Air and Missile Defense Technology mission, Lincoln Laboratory develops and assesses integrated systems for defense against ballistic missiles, cruise missiles, and air vehicles in tactical, regional, and homeland defense applications. Activities include the investigation of system architectures, development of advanced sensor and decision support technologies, development of flight-test hardware, extensive field measurements and data analysis, and the verification and assessment of deployed system capabilities. A strong emphasis is on rapidly prototyping sensor and system concepts and algorithms, and on transferring resulting technologies to government contractors responsible for developing operational systems.

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30.
Communications Systems
Lincoln Laboratory is working to enhance and protect the capabilities of the nation’s global defense networks. Emphasis is placed on synthesizing system architectures, developing component technologies, building and demonstrating end-to-end system prototypes, and then transferring this technology to industry for deployment in operational systems. Current efforts span all network layers (from physical to application), with primary focuses on radio-frequency military satellite communications, free-space laser communications, and line-of-sight networking.

Cyber Security and Information Sciences
Lincoln Laboratory conducts research, development, evaluation, and deployment of prototype components and systems designed to improve the security of computer networks, hosts, and applications. Efforts include cyber analysis; creation and demonstration of architectures that can operate through cyber attacks; development of prototypes that demonstrate the practicality and value of new techniques for cryptography, automated threat analysis, anti-tamper systems, and malicious code detection; and, where appropriate, deployment of prototype technology to national-level exercises and operations. To complement this work, advanced hardware, software, and algorithm technologies are developed for processing large, high-dimensional datasets from a wide range of sources. In the human language technology area, emphasis is placed on realistic data and experimental evaluation of techniques for speech recognition, dialect identification, speech and audio signal enhancement, and machine translation.

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30.
Intelligence, Surveillance, and Reconnaissance Systems and Technology

To expand intelligence, surveillance, and reconnaissance (ISR) capabilities, Lincoln Laboratory conducts research and development in advanced sensing, signal and image processing, automatic target classification, decision support systems, and high-performance computing. By leveraging these disciplines, the Laboratory produces novel ISR system concepts for both surface and undersea surveillance applications. Sensor technology for ISR includes passive and active electro-optical systems, surface surveillance radar, radio-frequency geolocation, and undersea acoustic surveillance. Increasingly, the work extends from sensors and sensor platforms to include the processing, exploitation, and dissemination architectures that connect sensors to operational users. Prototype ISR systems developed from successful concepts are then transitioned to industry and the user community.

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30.*
Space Control
The Space Control mission develops technology that enables the nation’s space surveillance system to meet the challenges of space situational awareness. The Laboratory works with systems to detect, track, and identify man-made satellites; performs satellite mission and payload assessment; and investigates technology to improve monitoring of the space environment, including space weather and atmospheric and ionospheric effects. The technology emphasis is the application of new components and algorithms to enable sensors with greatly enhanced capabilities and to support the development of net-centric processing systems for the nation’s Space Surveillance Network.

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30.*
**Advanced Technology**

Research and development in Advanced Technology supports the entire Laboratory by identifying new phenomenologies that can be exploited in novel system applications and by developing revolutionary advances in subsystem and component technologies that enable new system capabilities. This work is highly multidisciplinary, leveraging solid-state electronic and electro-optical technologies, innovative chemistry, and advanced radio-frequency (RF) technology. Recent developments include world-class imagers and detectors, novel three-dimensional electronic-photonic integration techniques, unique digital and quantum information systems technology, novel engineered materials, chemical-agent sensors, state-of-the-art lasers and photonic devices, and advanced antenna arrays and RF transceivers.

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30.*
Tactical Systems

In the Tactical Systems mission, Lincoln Laboratory assists the Department of Defense in improving the acquisition and employment of various tactical air and counterterrorist systems by helping the U.S. military understand the operational utility and limitations of advanced technologies. Activities focus on a combination of systems analysis to assess technology impact in operationally relevant scenarios, rapid development and instrumentation of prototype U.S. and threat systems, and detailed, realistic, instrumented testing. A tight coupling between the Laboratory’s efforts and the Department of Defense sponsors and warfighters involved in these efforts ensures that these analyses and prototype systems are relevant and beneficial to the warfighter.

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30.*
Homeland Protection
The Homeland Protection mission supports the nation’s security by innovating technology and architectures to help prevent terrorist attacks within the United States, to reduce the vulnerability of the nation to terrorism, to minimize the damage from terrorist attacks, and to facilitate recovery from either man-made or natural disasters. The broad sponsorship for this mission area spans the Department of Defense (DoD), the Department of Homeland Security (DHS), and other federal, state, and local entities. Recent efforts include architecture studies for the defense of civilians and facilities against biological attacks, development of the Enhanced Regional Situation Awareness system for the National Capital Region, the assessment of technologies for border and maritime security, and the development of architectures and systems for disaster response.

Homeland Protection
Department of Defense Authorized Funding
Fiscal Years 2008–2012*

*Lincoln Laboratory fiscal year runs concurrent with the U.S. Government fiscal year, October 1–September 30.
Lincoln Laboratory Staffing
Lincoln Laboratory employs 1,736 technical staff, 396 technical support personnel, 1,048 support personnel, and 573 subcontractors. Almost three-quarters of the technical staff have advanced degrees, with 41% holding doctorates. Professional development opportunities and challenging cross-disciplinary projects are responsible for the Laboratory’s ability to retain highly qualified, creative staff.

Lincoln Laboratory recruits at more than 60 of the nation’s top technical universities, with 65 to 75% of new hires coming directly from universities. Lincoln Laboratory augments its campus recruiting by developing long-term relationships with research faculty and promoting fellowship and summer internship programs.

Professional Technical Staff Profile

Degrees Held by Lincoln Laboratory Professional Technical Staff

- Doctorate: 41%
- Master’s: 34%
- Bachelor’s: 22%
- No Degree: 3%

Academic Disciplines of Lincoln Laboratory Professional Technical Staff

- Electrical Engineering: 36%
- Physics: 16%
- Engineering: 6%
- Mathematics: 8%
- Computer Science, Computer Engineering, Computer Information Systems: 17%
- Biology, Chemistry, Meteorology, Materials Science: 9%
- Aerospace/Astronautics: 5%
- Other: 3%
Test Facilities and Field Sites

Hanscom Field Flight and Antenna Test Facility
The Laboratory operates the main hangar on the Hanscom Air Force Base flight line. This ~93,000-sq-ft building accommodates the Laboratory Flight Test Facility and a complex of state-of-the-art antenna test chambers. The Flight Facility houses several Lincoln Laboratory–operated aircraft used for rapid prototyping of airborne sensors and communications.

Millstone Hill Field Site, Westford, MA
MIT operates radio astronomy and atmospheric research facilities at Millstone Hill, an MIT-owned, 1,100-acre research facility in Westford, Massachusetts. Lincoln Laboratory occupies a subset of the facilities whose primary activities involve tracking and identification of space objects.

Reagan Test Site, Kwajalein, Marshall Islands
Lincoln Laboratory serves as the scientific advisor to the Reagan Test Site at the U.S. Army Kwajalein Atoll installation located about 2,500 miles WSW of Hawaii. Twenty staff members work at this site, serving two- to three-year tours of duty. The site’s radars and optical and telemetry sensors support ballistic missile defense testing and space surveillance. The radar systems provide test facilities for radar technology development and for the development of ballistic missile defense techniques.

Other Sites
Pacific Missile Range Facility, Kauai, Hawaii
Experimental Test Site, Socorro, New Mexico
Section 5
MIT and Industry

- Partnering at MIT: 80
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MIT and Industry

MIT is built on a foundation of innovation and entrepreneurship. Since its creation in 1861 by the Massachusetts State Legislature, MIT has been charged with the “development and practical applications of science in connection with arts, agriculture, manufacturers, and commerce.” The Institute’s motto, mens et manus—mind and hand—codifies its continuing commitment to servicing society through the practical application of university research.

- According to the National Science Foundation, MIT ranks first in industry-financed R&D expenditures among all universities and colleges without a medical school.
- In FY2012, 712 companies provided R&D/gift support to MIT; 41 companies funded $1 million+, 174 companies funded $100 thousand–$1 million.
- Currently over 700 companies are working with faculty and students on projects of mutual interest. Among these corporate sponsors are such global leaders as BAE, BP, Boeing, DuPont, Eni, Ford Motor, Google, Intel, Lockheed Martin, Novartis, Quanta Computer, Raytheon, Samsung, Sanofi, Shell, Siemens, TOTAL, etc.

Partnering at MIT

Industry partners at MIT are global industry leaders who understand that technological advantage and innovation are key drivers to their competitive advantage. These are leaders who have created and defined industries, who quickly grasp the implications of breakthrough technology. Industry managers engage fully in MIT’s collaborative, interdisciplinary culture, and join big thinkers who are perpetually focused on wringing practical applications from excellent ideas.

Strategic Partnerships

In 1994, MIT began to build new kinds of research partnerships, creating longer-term alliances with major corporations that would allow these companies to work with MIT to develop programs and strategies that address areas of rapid change. In return for their research and teaching support, the corporations share ownership of patentable inventions and improvements developed from the partnership. In a number of these alliances, funds are earmarked for specific education projects.

A selection of these partnerships are described below.

DuPont

Established in 2000, the DuPont MIT Alliance (DMA) brings together each institution’s strengths in materials and chemical and biological sciences to develop new materials for bioelectronics, biosensors, biomimetic materials, alternative energy sources, and new high-value materials. DuPont also works with MIT’s Sloan School of Management to define new business and policy models for these emerging technologies. Each year, the DMA supports first-year graduate students through it’s DuPont Fellows program.
**Eni S.p.A**
In February 2008, an alliance was signed between Eni and MIT. This alliance brought the creation of the Eni-MIT Solar Frontiers Center (SFC). The SFC, headquartered on the MIT campus, promotes research in advanced solar technologies through projects ranging from new materials to hydrogen production from solar energy. Eni collaboration with MIT promotes the creation of technological and cultural synergies through a multidisciplinary approach. In particular, the cooperation between MIT researchers and those of the Research Center for Non Conventional Energy, Eni Donegani Institute, promotes the exchange of expertise through the pursuit of common objectives. In addition to the SFC, Eni supports projects in energy research at MIT on traditional hydrocarbons, methane hydrates, global climate change, and transportation options.

**Ford Motor Company**
Ford and MIT have been collaborating since the 1950s. In 1998 the Ford-MIT Alliance was formalized and has created a model for mutually beneficial university-corporate research. Ford and MIT collaborate on a broad range of technical, business, and policy topics focused on the future of transportation, including: vehicle autonomy, active safety, materials science, energy storage, powertrain efficiency, enterprise modeling, and health and wellness.

**Novartis**
Novartis and MIT have launched a long-term research collaboration aimed at transforming the way pharmaceuticals are produced. The partnership, known as the Novartis-MIT Center for Continuous Manufacturing, will work to develop new technologies that could replace the conventional batch-based system in the pharmaceuticals industry—which often includes many interruptions and work at separate sites—with continuous manufacturing processes from start to finish. The Novartis-MIT Center for Continuous Manufacturing combines the industrial expertise of Novartis with MIT’s leadership in scientific and technological innovation.

**Project Oxygen Alliance**
A partnership among the MIT Computer Science and Artificial Intelligence Laboratory and six corporations—Acer, Delta Electronics, Hewlett-Packard, Nippon Telegraph and Telephone, Nokia Research Center, and Philips Research—Project Oxygen’s goal is to make computation and communication resources as abundant and easy to use as oxygen. Working also with support from the Defense Advanced Research Projects Agency, the project seeks to free people from computer jargon, keyboards, mice, and other specialized devices they rely on now for access to computation and communication. For example, the researchers are creating speech and vision technologies that enable humans to communicate as naturally with computers as they do with people.

**Quanta Computing**
Taiwan-based Quanta Computer Inc., the world’s largest original design manufacturer of notebook computers, and MIT Computer Science and Artificial Intelligence Laboratory began the T-Party project collaboration in 2005. The goal of this project is to make the dream of having complete access to your own personalized environment—your notes, presentations, music, TV recordings, photo albums, recipes—from anywhere in the world, anytime a reality. The technologies they are exploring to support their vision fall into five categories: connectivity, devices, applications, automation, and natural interactions.
Selected Projects

MIT report identifies keys to new American innovation
An intensive, long-term study by a group of MIT scholars suggests that a renewed commitment to research and development in manufacturing, sometimes through creative new forms of collaboration, can spur innovation and growth in the United States as a whole. The findings are outlined in a 2013 report issued by a special MIT commission on innovation, called Production in the Innovation Economy, co-chaired by Suzanne Berger and Phillip A. Sharp. The report follows two years of in-depth research on hundreds of firms across various industrial sectors, ranging in size from high-tech startups to small “Main Street” manufacturers and multinational corporations.

MIT researchers build Quad HD TV chip
In January 2013, several manufacturers debuted new ultrahigh-definition, or UHD, models (also known as 4K or Quad HD) with four times the resolution of today’s HD TVs. In addition to screens with four times the pixels, UHD also requires a new video-coding standard, known as high-efficiency video coding, or HEVC. In February 2013, MIT researchers unveiled their own HEVC chip. The chip was designed by Anantha Chandrakasan, graduate students Mehul Tikekar and Chiraag Juvekar, former postdoc Chao-Tsung Huang, and former graduate student Vivienne Sze, now at Texas Instruments (TI). The researchers’ design was executed by the Taiwan Semiconductor Manufacturing Company, through its University Shuttle Program, and TI funded the chip’s development.

A cooler way to protect silicon surfaces
Silicon, the material of high-tech devices from computer chips to solar cells, requires a surface coating that “passivates” it to prevent oxidation that would ruin its electrical properties. Typically, silicon surfaces are passivated with a coating of silicon nitride, which requires heating a device to 400 degrees Celsius. By contrast, the process Karen Gleason, Tonio Buonassisi, and graduate student Rong Yang uses organic vapors over wires heated to 300°C, but the silicon itself never goes above 20°C—room temperature. Heating those wires requires much less power than illuminating an ordinary light bulb, so the energy costs of the process are quite low. The research was supported by the Italian energy company Eni S.p.A., under the Eni-MIT Alliance Solar Frontiers Program.

Continuous drug manufacturing offers speed, lower costs
Traditional drug manufacturing is a time-consuming process. Active pharmaceutical ingredients are synthesized in a chemical manufacturing plant and then shipped to another site where they are converted into giant batches of pills. In 2007, MIT and pharmaceutical company Novartis launched a research effort, known as the Novartis-MIT Center for Continuous Manufacturing, to transform those procedures. Bernhardt Trout and other MIT researchers have now developed and demonstrated a prototype continuous-manufacturing system—the first that can transform raw materials into tablets in a nonstop process. In addition to Trout, MIT faculty members involved in the project include Klavs Jensen, Stephen Buchwald, Tim Jamison, Gregory Rutledge, Allan Myerson, Paul Barton, and Richard Braatz.
Campus Research Sponsored by Industry

Industry Campus and Broad Institute Research Expenditures (in U.S. Dollars)*
Fiscal Years 2008–2012

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
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<tbody>
<tr>
<td>Campus research</td>
<td>75,259,081</td>
<td>85,562,146</td>
<td>92,649,701</td>
<td>100,762,512</td>
<td>109,744,829</td>
</tr>
<tr>
<td>Broad Institute research</td>
<td>6,935,104</td>
<td>13,656,981</td>
<td>680,132</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total Industry</td>
<td>82,194,185</td>
<td>99,219,127</td>
<td>93,329,833</td>
<td>100,762,512</td>
<td>109,744,829</td>
</tr>
<tr>
<td>Constant dollars†</td>
<td>88,352,894</td>
<td>105,185,002</td>
<td>97,993,272</td>
<td>103,714,730</td>
<td>109,744,829</td>
</tr>
</tbody>
</table>

*The Broad Institute separated from MIT on July 1, 2009 and no longer receives funding through MIT. The chart above displays both MIT campus research expenditures and Broad Institute research expenditures funded through MIT.
†Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2012 equaling 100.

Leading Departments, Laboratories, and Centers Receiving Support in Fiscal Year 2012
(shown in descending order of expenditures)

MIT Energy Initiative
Chemical Engineering
Computer Science and Artificial Intelligence Laboratory
Media Laboratory
Sloan School of Management
Mechanical Engineering
Koch Institute for Integrative Cancer Research
Sociotechnical Systems Research Center
Aeronautics and Astronautics
Research Laboratory of Electronics

MIT is a leader in conducting research sponsored by industry. Approximately 200 industrial sponsors supported research projects on the MIT campus in FY2012, with nearly $110 million in expenditures. Companies often join together in these collaborations to support multi-disciplinary research programs in a wide range of fields.
Managing the Industry/University Interface

Drawing on decades of successful industry collaboration, MIT has assembled a coordinated team of professionals who expertly manage the important industry/university interface, leveraging and exploiting proven pathways for two-way knowledge transfer.

Industrial Liaison Program

Officers at MIT’s Industrial Liaison Program (ILP) help company managers by scheduling and facilitating face-to-face meetings with MIT faculty, coordinating on-campus networking activities, and advising company managers on how to navigate, adapt and benefit from the dynamic, interdisciplinary MIT environment. Over 200 of the world’s leading companies partner with the Industrial Liaison Program to advance their research agendas at MIT, and ILP member companies account for approximately 54% of all single-sponsored research expenditures and corporate gifts/grants at MIT (FY2012).

Office of Corporate Relations

MIT’s Office of Corporate Relations (OCR), the organizational parent of the ILP, aids and directs companies interested in pursuing significant, multi-year, multi-disciplinary involvement with the Institute. OCR works with MIT senior administration, faculty, and company executives to structure and define individualized alliances that mutually benefit the company and MIT. The result is a holistic industry/university relationship that addresses broad needs and interests, from specific research projects and initiatives, to executive education, technology licensing, and recruitment.

Technology Licensing Office

The MIT Technology Licensing Office (TLO) is a world class model of excellence in university technology licensing. Its staff is especially attuned to the needs of pre-competitive research and promotes an Intellectual Property protocol that accelerates commercialization, and, at the same time, honors MIT’s obligations to education and research. The TLO oversees a vibrant flow patenting/licensing activity

<table>
<thead>
<tr>
<th>Technology Licensing Office Statistics for FY2012</th>
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<tbody>
<tr>
<td>Total number of invention disclosures</td>
</tr>
<tr>
<td>Number of U.S. new utility patent applications filed</td>
</tr>
<tr>
<td>Number of U.S. patents issued</td>
</tr>
<tr>
<td>Number of licenses granted (not including trademarks and end-use software)</td>
</tr>
<tr>
<td>Number of options granted (not including options as part of research agreements)</td>
</tr>
<tr>
<td>Number of software end-use licenses granted</td>
</tr>
<tr>
<td>Number of companies started (venture capitalized and/or with a minimum of $500K of other funding)</td>
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</tbody>
</table>

Entrepreneurship

Beginning with the founding of Arthur D. Little, Inc. in Cambridge in 1886, MIT alumni, faculty, and students have played key roles in launching thousands of companies worldwide, ranging from small, specialized high-tech operations to corporate giants such as Genentech, Gillette, Hewlett-Packard, Teradyne, and Raytheon. Many of these companies have formed the cornerstone of new industries, including biotechnology, streamlined digital technologies, local computer networks, defense, semi-conductors, minicomputers, advanced computers, and venture capital. MIT scientists and entrepreneurs laid the groundwork for much of the current biotech industry, and biomedical advances have continued with MIT-originated developments such as the first effective new treatment for brain cancer in a generation.

- According to a 2009 Kauffman Foundation Entrepreneurship Study, 25,000+ companies have been founded by MIT alums creating 3.3+ million jobs and $2 trillion in annual world sales.
- Five states gaining the most jobs from companies started by MIT alumni were Massachusetts, with just under 1 million jobs; California, with 526,000 jobs; New York, with 231,000 jobs; Texas, with 184,000 jobs; and Virginia, with 136,000 jobs.
- MIT acts as a magnet for foreign entrepreneurs. Half of those companies created by “imported” entrepreneurs, 2,340 firms, are headquartered in the United States, generating their principal revenue ($16 billion) and employment (101,500 people) benefits here.”
Martin Trust Center for MIT Entrepreneurship
The Martin Trust Center for MIT Entrepreneurship is committed to fostering and developing MIT’s entrepreneurial activities and interests in three primary areas: education and research, alliance, and community. The Center educates and nurtures students from across the Institute who are interested in learning the skills to design, launch, and grow innovation-based ventures. The Center facilitates business and technology partnerships by combining breakthrough academic research with practical, proven experience. The people of the Center cultivate and nourish a thriving network that unifies academic, government, and industry leaders around the vision of entrepreneurial success.

Deshpande Center for Technological Innovation
The Deshpande Center for Technological Innovation was established at the MIT School of Engineering in 2002 to increase the impact of MIT technologies in the marketplace, and support a wide range of emerging technologies including biotechnology, biomedical devices, information technology, new materials, tiny tech, and energy innovations. Since 2002, the Deshpande Center has funded more than 80 projects with over $9 million in grants. Eighteen projects have spun out of the center into commercial ventures, having collectively raised over $140 million in outside financing. Thirteen venture capital firms have invested in these ventures.

$100K Entrepreneurship Competition
The MIT $100K Entrepreneurship Competition (student group) is the leading business plan competition in the world. The competition was founded in 1990 to encourage students and researchers in the MIT community to act on their talent, ideas, and energy to produce tomorrow’s leading firms. Entirely student-managed, the competition has produced hundreds of successful ventures that have created value and employment.

Learning
Sloan Executive Education
MIT Sloan Executive Education programs are designed for senior executives and high-potential managers from around the world. From intensive two-day courses focused on a particular area of interest, to executive certificates covering a range of management topics, to custom engagements addressing the specific business challenges of a particular organization, their portfolio of non-degree, executive education and management programs provides business professionals with a targeted and flexible means to advance their career development goals and position their organizations for future growth.

Professional Education
MIT Professional Education provides short courses, semester or longer learning programs and customized corporate programs for science and engineering professionals at all levels. Taught by renowned faculty from across the Institute, MIT Professional Education programs offer professionals the opportunity to gain crucial knowledge in specialized fields to advance their careers, help their companies, and have an impact on the world.

- Short Programs—Over 40 courses, in two-to-five day sessions, are taught on the MIT campus each summer by MIT faculty/researchers and experts from industry and academia. Participants earn Continuing Education Units (CEUs) and a certificate of completion.

- Advanced Study Program—Enroll at MIT for a 16-week, non-matriculating, non-degree program that enables professionals to take regular MIT courses to gain the knowledge and skills needed to advance their careers and take innovative ideas back to their employers Participants earn grades, MIT credit, and an Advanced Study Program certificate.

- Custom Programs—Enhance your organization’s capabilities and expertise through customized programs tailored to meet your specific needs and priorities. These programs can be a single week or several weeks over a year with interrelated projects. These specialized courses can be delivered at MIT, the company site, or off site.
Leaders for Global Operations
The Leaders for Global Operations (LGO) program is an educational and research partnership among global operations companies and MIT’s School of Engineering and Sloan School of Management. Its objective is to discover, codify, teach, and otherwise disseminate guiding principles for world-class manufacturing and operations. The 24-month LGO program combines graduate education in engineering and management for those with two or more years of full-time work experience who aspire to leadership positions in manufacturing or operations companies. A required six-month internship comprising a research project at one of LGO’s partner companies leads to a dual-degree thesis, culminating in two master’s degrees—an MBA (or SM in management) and an SM in engineering.

MIT Sloan Fellows Program in Innovation and Global Leadership
This full-time, 12-month (June–June) immersive MBA program is designed for high-performing mid-career professionals. The program typically enrolls more than 100 outstanding individuals with 10–20 years of professional experience from at least two dozen nations, representing a wide variety of for-profit and nonprofit industries, organizations, and functional areas. Many participants are sponsored by or have the strong support of their employers, but the program also admits independent participants, many with unique entrepreneurial experiences and perspectives. The program is characterized by a rigorous academic curriculum, frequent interactions with international business and government leaders, and a valuable exchange of global perspectives.

System Design and Management
The System Design and Management program educates engineering professionals in the processes of engineering and designing complex products and systems and gives them the management skills they need to exercise these capacities across organizations. Sponsored by the School of Engineering and the Sloan School of Management, the program offers a joint master’s degree from both schools. Students can pursue these degrees either on campus or through a hybrid on-campus/off-campus curriculum that uses video conferencing and web-based instruction.

Recruiting
Global Education and Career Development
The MIT Global Education and Career Development center assists employers in coordinating successful on- and off-campus recruitment of MIT students and provides students with opportunities to interact and network with professionals and obtain quality internships and full-time positions. MIT is proud to serve the needs of undergraduates (including Sloan), graduates and MIT alumni. (Departments that conduct their own recruiting include Chemistry, Chemical Engineering, and Sloan School of Management).

Sloan’s Career Development Office
Sloan’s Career Development Office (CDO) serves a vital role in connecting MIT Sloan’s innovative master’s students and alumni with the world’s leading firms. The CDO is dedicated to supporting employer recruiting goals and helping them identify the best candidates for their organization.
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Global Engagement

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Global Engagement

MIT’s problem-solving ambitions are global, and we cannot solve the most important world problems alone. Our wide-ranging international collaborations allow us access to outstanding students and colleagues, and provide our students with hands-on preparation for worldwide careers. Just as important, our global engagements lead us to important research problems and to fresh ways of thinking. While we are eager to share what we know, we go out into the world to learn.

President L. Rafael Reif

MIT strives to encourage the free flow of people and ideas by engaging in international research collaborations, providing international study and research opportunities for its students, and hosting international students and scholars. The following are some of MIT’s many international research collaborations.

Singapore

Singapore University of Technology and Design
In 2010, MIT and the Singapore University of Technology and Design (SUTD) officially began a partnership that includes both education and research components. Under the education component, MIT will share its expertise with SUTD in a broad range of areas, including pedagogy, curriculum development, and faculty recruitment and development. MIT will also assist in designing programs to encourage innovation and entrepreneurship. The first cohort has successfully finished its freshmen year. The second incoming class matriculated in May 2013. A key feature of the research component is the new SUTD-MIT International Design Centre (IDC). The IDC is a joint research project with facilities at both universities. The IDC aims to become the world’s premier scholarly hub for technologically intensive design and serve as a nucleus for the growth of the MIT-SUTD Collaboration.

Singapore-MIT Alliance
The Singapore-MIT Alliance is a global partnership in graduate education created by MIT, the National University of Singapore, and Nanyang Technological University. Setting a new standard for international collaboration in graduate research and education, the alliance educates young engineers to serve as leaders in a technologically advanced economy, and creates a cohort of students and faculty with creativity and entrepreneurial spirit.

http://web.mit.edu/sma/

Singapore-MIT Alliance for Research and Technology Centre
The Singapore-MIT Alliance for Research and Technology (SMART) Centre is a research enterprise established by MIT in partnership with the National Research Foundation of Singapore. The SMART Centre serves as an intellectual hub for research interactions between MIT and Singapore at the frontiers of science and technology. This partnership allows faculty, researchers, and graduate students from MIT to collaborate with their counterparts from universities, polytechnics, research institutes, and industry in Singapore and throughout Asia. The SMART Centre is MIT’s first research centre outside of Cambridge, Massachusetts, and its largest international research endeavor. See page 93 for information on Singapore-MIT Undergraduate Research Fellowships.

http://smart.mit.edu/

Russia

MIT Skoltech Initiative
In 2011, a multi-year collaboration began between the Skolkovo Foundation, the Skolkovo Institute of Science and Technology (Skoltech), and MIT to develop a new graduate research university. MIT will act as an advisor on programs, structure, and curriculum during the launch period. Located near Moscow, the new institution aims to break ground in bringing together Russian, U.S., and global research and technology, and in integrating research, teaching, innovation, and entrepreneurship. Research and education at Skoltech is organized around multidisciplinary technological challenges, rather than traditional academic disciplines. The institution focuses on the following themes: biomedical science
and technology, energy science and technology, information science and technology, nuclear science and technology, and space science and technology. Fifteen multidisciplinary and multi-institutional research centers—known as Centers for Research, Education, and Innovation—are being created under the Skoltech organizational umbrella to address critical scientific and technology challenges. The first three centers in the fields of energy and biomedicine are scheduled to launch in 2013. In each center, faculty, researchers, and students from one or more Russian universities will collaborate with teams from one or more universities outside Russia. A defining component being developed in collaboration with MIT, Skoltech’s Center for Entrepreneurship and Innovation works to support a culture of entrepreneurship and innovation across the university.

http://web.mit.edu/sktech/

India

Tata Center for Technology and Design
The Tata Center for Technology and Design was launched at MIT in the summer of 2012 with a generous gift from the Sir Dorabji Tata and Allied Trusts. The Trusts are chaired by Mr. Ratan Tata, who recently retired as Chairman of Tata Sons, the well-known Indian industrial conglomerate. Mr. Tata is also a member of the External Advisory Board of the MIT Energy Initiative. The mission of the Center is to create a graduate education program that teaches graduate students how to apply deep technical knowledge to the challenges of the developing world - guided by direct experience in India. Each year, the Center will support between 30 and 40 Masters and Ph.D. students, known as Tata Fellows, from all Schools and Departments. These students are required to satisfy their departmental degree course and thesis requirements, and in consultation with their departmental supervisors, develop thesis projects that respond to large-scale opportunities to use technology effectively to improve the lives of those in the lower strata of Indian society. The Center provides travel funds that enable students to spend several months in India while earning their degrees—mainly during IAP and summer months. In the course of two years, students are expected to produce product or system designs that help to overcome the challenges presented by the context of developing India.

China

MIT-China Low Carbon Energy Leaders
In early 2011, at the recommendation of the MIT Greater China Strategy Committee, MITEI launched a novel executive education program on energy technology and policy designed to share the U.S. perspective on low carbon energy technology and policy with senior Chinese officials from government and business. MITEI collaborates with a faculty team from Shanghai Jiao Tong University to present three program sessions per year, each attended by between 25 and 30 Chinese SOE executives, and senior provincial and national government officials. The intent of the MIT-China Low Carbon Energy Leaders Program (LCELP) is to equip Chinese energy leaders to develop effective strategies to balance the demands of economic growth and environmental stewardship in China. Each intensive seven-day session is made up of lectures, panel discussions and tours featuring many of MIT’s best known energy faculty. In 2013, the LCELP was the top-ranked university led executive education program in China.

China Leaders for Global Operations (CLGO)
The China Leaders for Global Operations (CLGO) program was started in 2005 as a collaboration between MIT and the Shanghai Jiao Tong University (SJTU). The program was launched at the request of LGO industry partners to strengthen LGO global content for faculty and students, help partner companies’ operations in China, and promote global manufacturing. CLGO offers China’s only dual-degree, graduate-level academic program. The CLGO program is jointly offered by SJTU’s two engineering schools, the SJTU Antai College of Economics and Management, and a dedicated group of CLGO industry partners. Graduates of the CLGO program receive the MBA degree from Antai, an S.M. degree from one of two SJTU engineering schools, and a certificate from the MIT LGO program. MIT supports the China LGO program by hosting SJTU faculty (28 to date) at MIT for extensive mentoring in courses that they in turn lead for the CLGO program, and by providing the all-English language CLGO curriculum. In addition, a review committee of MIT faculty makes periodic visits to meet CLGO stakeholders and assess the program’s quality.
MIT China Educational Technology Initiative
The MIT-China Educational Technology Initiative (CETI) is MISTI-China’s educational technology internship program. Since 1997, MIT-CETI has trained small teams of MIT students to work with numerous universities and high schools in China, building cross-cultural understanding between Chinese and American students through the application of technology. Approximately 20 MIT students participate in CETI each year in full summer and longer internships. CETI has established educational technology programs with Chinese universities through partnerships with MIT OpenCourseWare (OCW) and MIT-iCampus. CETI university partners include Dalian University of Technology, Huazhong University of Science and Technology (Wuhan), Fuzhou University, Xi’an Jiaotong University, Yunlin University (Shaanxi Province), Qinghai University, Sichuan University, Kunming University of Science and Technology, Institute of Vocational Engineering (Hong Kong), and YuanZe University (Taiwan). In recent years, CETI has also held several educational technology summer camps at Tsinghua and Zhejiang universities in the departments of information technology.

Middle East

MIT and Masdar Institute Cooperative Program
In 2006, MIT began collaborating with the government of Abu Dhabi to establish a graduate research university focused on alternative energy, sustainability, and advanced technology. Since then the Masdar Institute has attracted over 75 outstanding faculty and over 300 graduate students, built the first phase of a state-of-the-art campus and laboratories, and launched more than 50 joint collaborative research projects with MIT. The MIT and Masdar Institute Cooperative Program supports Abu Dhabi’s goal of developing human capital for a diversified knowledge-based economy. By ensuring high-quality, graduate education and advanced research, Masdar Institute prepares a high-caliber workforce to keep pace with ever-increasing technological changes and a growing research and development culture. The Cooperative Program offers MIT and Masdar Institute faculty and students access to new talent, ideas, and rich research and educational collaborations.

http://web.mit.edu/mit-mi-cp/
http://www.masdar.ac.ae/

CSAIL-Qatar Computing Research Institute
The CSAIL-Qatar Computing Research Institute (QCRI) research collaboration, called the Computer Science Research Program, is a medium for knowledge transfer and exchange of expertise between MIT-CSAIL and QCRI scientists. Scientists from both organizations are undertaking a variety of core computer science research projects with the goal of developing innovative solutions that can have a broad and meaningful impact. The agreement also offers CSAIL researchers and students exposure to the unique challenges in the Gulf region. Through the Computer Science Research Program, researchers are focusing on several critical areas in the field of computing including distributed systems, data analytics, social computing, and Arabic language technologies. Scientists at QCRI are benefiting from the expertise of MIT’s eminent faculty through joint research projects that will enable QCRI to realize its vision to become a center of computing research internationally and a global recognized leader in Arabic language technologies.

Center for Clean Water and Clean Energy at MIT and KFUPM
A group of Mechanical Engineering faculty have entered into an eight-year research and educational collaboration with King Fahd University of Petroleum and Minerals (KFUPM) in Dhahran, Saudi Arabia, housed within the Center for Clean Water and Clean Energy. The Center’s research focuses on water desalination and purification and on low-carbon energy production from both solar energy and fossil fuels. Additional research activities involve design and manufacturing, with a focus on technologies related to water and energy production. This collaboration began in fall 2008. The collaboration includes more than 150 faculty and students at the two institutions. During the first 4.5 years, more than 200 publications have been produced and dozens of patent applications have been filed. In addition, the Center includes a program to bring postdoctoral Saudi Arabian women to MIT for research activities. The Center is directed by Professor John H. Lienhard V and co-directed by Professor Kamal Youcef-Toumi.
Portugal
MIT Portugal Program
The MIT Portugal Program was launched in October 2006 by the Portuguese Ministry of Science, Technology, and Higher Education as a large-scale international collaboration connecting MIT to government, academia, and industry in Portugal. The aim of the program is to transform the Portuguese economy by developing globally competitive higher education programs and critical-mass research in four critical engineering systems domains: bioengineering systems, sustainable energy systems, engineering design and advanced manufacturing, and transportation systems. These academic initiatives are complemented by an array of ecosystem-building activities, including a highly successful student venture competition. The partnership has recently been extended for a second 5-year phase, underscoring its importance for the Portuguese government and the value MIT brings to the country.

Other Global Initiatives
Global Supply Chain and Logistics Excellence (SCALE) Network
The MIT Center for Transportation and Logistics (MIT-CTL) created the MIT Global Supply Chain and Logistics Excellence (SCALE) Network in 2003 as an international alliance of leading research and education centers dedicated to the development and dissemination of supply chain and logistics innovation. This international network now spans four continents with Centers in North America (MIT CTL), Europe (Zaragoza, Spain), South America (Bogota, Colombia), and Asia (Kuala Lumpur, Malaysia). Each SCALE Center fosters relationships between its local students, faculty, and businesses as well as those across the network. More than 100 graduate students are enrolled annually in the various SCALE supply chain educational programs; each of which includes a three week student & faculty exchange at MIT. The SCALE Network also features partnerships with close to a hundred global corporations, such as Procter & Gamble, UPS, BASF, and Wal-Mart, that sponsor research, participate in events, and recruit students. Research projects recently undertaken by the SCALE network include projects on decision making under uncertainty, supply chain resilience, humanitarian logistics, sustainable supply chains, and global transportation reliability.

Center for Advanced Urbanism
The MIT Center for Advanced Urbanism’s objective is to become the world’s pre-eminent cultural center about the design of metropolitan environments, by articulating methods and projects to integrate separate disciplinary agendas in architecture, landscape, ecology, transportation engineering, politics and political philosophy, technology and real estate through a most eloquent design culture on scales ranging from the complex infrastructural intersection, to that of a neighborhood, on to the scale of an entire regional system.

Digital Learning
MITx and edX
edX is a not-for-profit enterprise established by founding partners MIT and Harvard University that features learning designed specifically for interactive study via the web. edX is the open-source platform of choice for MIT, Harvard, and over a dozen other universities to provide so-called Massive Open Online Courses (MOOCs). The MIT courseware for edX is produced by the MITx office and referred to as MITx courseware.

Massive Open Online Courses offered to date by MITx include 2.01x Elements of Structures, 3.091x Introduction to Solid State Chemistry, 6.00x Introduction to Computer Science and Programming, 6.002x Circuits and Electronics, 7.00x Introduction to Biology—The Secret of Life, 8.02x Electricity and Magnetism, and 14.73x The Challenge of Global Poverty. These courses have received approximately 400,000 enrollments.

https://www.edx.org/
https://www.edx.org/university_profile/MITx
Digital Learning
(continued)

OpenCourseWare
Launched in 2002, OpenCourseWare (OCW) makes materials for MIT’s courses freely available on the Web. Materials from more than 2,100 MIT courses—including lecture notes, multimedia simulations, problem sets and solutions, past exams, reading lists, and selections of video lectures—are now posted on the OCW website. OCW records an average of over 70,000 visits a day, with 1.3 million unique visitors every month. In total, OCW materials are estimated to have reached 150 million individuals worldwide.

About half of OCW usage originates outside of North America. OCW materials are used extensively in India (160,000 visits per month) China (90,000 visits per month), and the Middle East (77,000 visits per month). OCW materials have been translated into Chinese, Spanish, Portuguese, Persian, Korean, Arabic and Thai. OCW also distributes and maintains mirror copies of the site at universities in bandwidth-constrained regions, primarily Sub-Saharan Africa. To date, the OCW staff has distributed more than 320 such mirrors.

MIT is pursuing two missions with OCW—sharing its educational materials freely and openly, and, by creating a model other universities can follow and advance, promoting a universally available storehouse for human knowledge. About 43 percent of OCW’s visitors identify themselves as self-learners, 42 percent as students enrolled in academic programs, and nine percent as educators.

The following are examples of ways educators, students, and self-learners in the international community use OCW content:

Nasik, India
Tuhin Bagi is captain of his school’s badminton team (the reigning champs), plays classical Indian music, frequently competes in regional science fairs, and follows a full curriculum of advanced courses in physics, chemistry and biology. His parents are strong supporters of his academic interests but found themselves challenged by his curiosity. “Tuhin is an eager learner,” explains his father, an industrial automation engineer, “and his interests took him far beyond his school syllabus. I tried to answer his questions and have regular sessions with him, but I could not always be home.” One day, while looking for online resources to help Tuhin answer a question in physics, his mother came across MIT OpenCourseWare. At first she worried that its material might be too advanced for a high school freshman, and wrote to OCW for advice. To her surprise, she received a personal response from revered MIT professor Walter Lewin, who suggested that Tuhin give his lectures a try. Tuhin loved the lectures immediately, and every day after school his mother would find him watching them on the computer (both 8.01 Physics I: Classical Mechanics and 8.02SC Physics II: Electricity and Magnetism). He sometimes needed to watch a single lecture several times to really capture everything, but acknowledges that it’s a big achievement for someone his age to follow a university-level science course. “It is a bit unusual,” he admits with a smile, “I don’t know anyone else at my school who is doing this.”

Ankara, Turkey
Ziya Deniz Eralp worked for several Turkish defense technology companies, first as a systems engineer and later as a project manager, before he discovered MIT OpenCourseWare (OCW). Deniz was thrilled to find course material within OCW that corresponded to his exact needs—it was a perfect opportunity to update his understanding of technology systems design at a key moment in his career: “In college, you take the classes to get the grades, but you don’t really understand the application. When you finally need the information, you have mostly forgotten about what they taught in the class. OCW is a great way of refreshing your knowledge.” Deniz admits with a smile that he may have gone a little overboard upon first discovering OCW on the Web. He downloaded dozens of hours of engineering and physics lectures and viewed them constantly. “It became a bit of a habit. While I was in the bus or waiting somewhere, I would watch course videos. It began to drive my wife a bit crazy because I was always watching them.” He eventually tamed his “addiction,” but credits OCW with exposing him to several new concepts that guided his approach for designing complex defense systems: “The area that I specialize in, systems engineering and architecture, is an emerging field that has not really settled down yet. The MIT approach offers a new way that is still hard to find in books.”

http://ocw.mit.edu/
International Study Opportunities
There are a broad range of global activities for students to choose from. These run the gamut from traditional study-abroad programs to innovative short term projects, but most are infused with the Institute’s philosophy of mens et manus. In the spring of 2012, 39 percent of students graduating with a bachelor’s degree, and 31 percent of students graduating with a master’s degree reported having educational experiences abroad.

The following are examples of programs that provide students with experiences abroad:

Cambridge-MIT Exchange
Undergraduate MIT students can spend their junior year studying at the University of Cambridge in England through the Cambridge-MIT Exchange Program (CME). The University of Cambridge consists of 31 colleges where students live and study in a supportive educational environment. The fourteen participating MIT departments are Aeronautics and Astronautics; Biology; Brain and Cognitive Sciences; Chemical Engineering; Chemistry; Civil and Environmental Engineering; Earth, Atmospheric, and Planetary Sciences; Economics; Electrical Engineering and Computer Science; History; Materials Science and Engineering; Mathematics; Mechanical Engineering; and Physics.

Departmental Exchanges
The Department of Aeronautics and Astronautics offers study at the University of Pretoria in South Africa. The Department of Architecture has two exchange programs, one with Delft University of Technology in the Netherlands and the other with the University of Hong Kong. The Department of Materials Science and Engineering has an exchange program with Oxford University. The Department of Political Science has started an exchange program with Sciences Po in Paris, France.

MIT-Madrid Program
The MIT-Madrid Program gives students the opportunity to study in Madrid for the spring term during their sophomore or junior year. Depending upon major and interests, students can choose science and engineering courses at the Universidad Politécnica de Madrid and/or humanities, arts, and social sciences courses at the Universidad Complutense de Madrid; instruction and coursework are in Spanish. These are leading universities in Spain, each with its distinguished tradition and history. In addition to academic courses, students can participate in an internship during this program.

Singapore-MIT Undergraduate Research Fellowships (SMURF)
The SMART Centre has established a summer research internship programme: the SMURF programme (Singapore-MIT Undergraduate Research Fellows programme). It is open to all undergraduates at MIT, NTU, and NUS and gives them the opportunity to engage in research at the SMART Centre over the summer. The SMURFs work in MIT Faculty supervisors’ labs, actively participate in the research projects, and engage with postdoctoral scholars, graduate students, and other researchers. SMART hopes this opportunity excites them about research and they consider a career in research. Their academic experiences are supplemented with numerous social activities that are arranged for them. Based on feedback from the students, the SMURFS greatly value their experiences at SMART and the community that forms among them.

Other Study Abroad Options
MIT students may also apply for admission directly to foreign institutions that offer study abroad programs or to a study abroad program administered by another U.S. institution or a study abroad provider. Examples of such opportunities include study at l’École Polytechnique in France, a year-long or summer program at the London School of Economics, and programs at Australian universities.
MIT International Science and Technology Initiatives

MIT International Science and Technology Initiatives (MISTI), MIT’s primary international program, connects MIT students and faculty with research and innovation around the world. Working closely with a network of premier corporations, universities and research institutes, MISTI matches over 680 MIT students with internships and research opportunities abroad each year. After several semesters of cultural and language preparation on campus, MISTI students participate in rigorous, practical work experience in industry and in academic labs and offices. Projects are designed to align the skills and interests of the student with the needs of the host. MISTI also organizes the MISTI Global Seed Funds, which encourage MIT students to work on faculty-led international research and projects. MISTI programs are available in Africa, Belgium, Brazil, Chile, China, France, Germany, India, Israel, Italy, Japan, Korea, Mexico, Russia, Singapore, Spain and Switzerland.

MISTI’s approach to international education builds on MIT’s distinctive traditions of combining classroom learning and hands-on experience in Undergraduate Research Opportunities (UROPs), cooperative programs with industry, practice schools, and internships. In contrast to other universities’ internationalization programs that mainly involve study abroad, MISTI matches individual students with work or research opportunities in their own fields.

MISTI was awarded the 2013 Senator Paul Simon Spotlight Award by NAFSA: Association of International Educators. According to NAFSA Executive Director and CEO Marlene M. Johnson, winners of the Simon Award are “excellent models for how higher education across the country can and must innovate to prepare our students for the global economy we live in today.”

Here are a few examples from the more than 4,000 students MISTI has placed since it began by sending a handful of interns to Japan at the end of the 80s:

- Chemical Engineering student Nathalia Rodriguez worked on gene therapy for muscular dystrophy at Genpole, a French biotech cluster.
- Physics major Jason Brylawskyj designed superconducting magnetic bearings for electric motors at Siemens in German. He wrote two patents at Siemens.
- Ammar Ammar, an EECS undergrad, designed and tested a Google/YouTube project at Google Israel.

http://web.mit.edu/misti/
MISTI Programs and Start Year

- Belgium, 2011
- Brazil, 2009
- Chile, 2011
- China, 1994
- France, 2001
- Germany, 1997
- India, 1998
- Israel, 2008
- Italy, 1999
- Japan, 1983
- Korea, 2012
- Mexico, 2004
- Russia, 2012
- Singapore, 2012
- Spain, 2006
- Switzerland, 2010

*MISTI year runs from September 1–August 31. 2012 represents the 2011–2012 year.
International Students

MIT has welcomed international students essentially since its inception. The first student from Canada came to MIT in 1866, the second year MIT offered classes. This student was followed by a steady stream of students from around the globe throughout the 19th century. By 1900, some 50 foreign-born students had traveled to Massachusetts for study; however, the number increased dramatically after World War II when an influx of these students began attending the Institute. The rapid rise of international students from East Asia, led by students from China, changed the demographics of this group beginning in the 1950s. Changes in immigration law in 1965 opened up the doors to a steadily increasing pool of international talent.

The United States has been the destination of choice for international students and scholars for the past 50 years. According to the Institute of International Education Open Doors 2012 report, the number of international students enrolled in U.S. colleges during the 2011–2012 academic year reached a record high of 765,000 students. MIT is ranked 33rd in the report’s “International Students by Institutional Type: Top 40 Doctorate Institutions, 2011/12” list. NAFSA: Association of International Educators produced an economic analysis based in part on Open Doors data that states that during the 2011–2012 academic year, international students contributed approximately $21.8 billion to the U.S. economy through living expenses for themselves and accompanying dependents, as well as through expenditures on tuition, books, fees, and other education-related expenses.

Total Enrollment by Citizenship and Geographic Region of Country of Citizenship
2012–2013

<table>
<thead>
<tr>
<th>Region</th>
<th>Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>US Citizen or Permanent Resident</td>
<td>72%</td>
</tr>
<tr>
<td>International</td>
<td>28%</td>
</tr>
<tr>
<td>Asia</td>
<td>14%</td>
</tr>
<tr>
<td>Europe</td>
<td>6%</td>
</tr>
<tr>
<td>Americas and Caribbean</td>
<td>5%</td>
</tr>
<tr>
<td>Africa, Middle East, Oceania</td>
<td>3%</td>
</tr>
<tr>
<td>Stateless</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>
**International Undergraduate Students**

**Top Countries of Citizenship, 2012–2013**

<table>
<thead>
<tr>
<th>Country</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>56</td>
</tr>
<tr>
<td>India</td>
<td>30</td>
</tr>
<tr>
<td>South Korea</td>
<td>26</td>
</tr>
<tr>
<td>Thailand</td>
<td>22</td>
</tr>
<tr>
<td>Canada</td>
<td>22</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>13</td>
</tr>
<tr>
<td>Vietnam</td>
<td>12</td>
</tr>
<tr>
<td>Taiwan</td>
<td>11</td>
</tr>
<tr>
<td>Pakistan</td>
<td>10</td>
</tr>
<tr>
<td>Brazil</td>
<td>10</td>
</tr>
<tr>
<td>Turkey</td>
<td>10</td>
</tr>
<tr>
<td>Singapore</td>
<td>10</td>
</tr>
</tbody>
</table>

**International Graduate Students**

**Top Countries of Citizenship, 2012–2013**

<table>
<thead>
<tr>
<th>Country</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>567</td>
</tr>
<tr>
<td>India</td>
<td>266</td>
</tr>
<tr>
<td>Canada</td>
<td>241</td>
</tr>
<tr>
<td>South Korea</td>
<td>238</td>
</tr>
<tr>
<td>Singapore</td>
<td>79</td>
</tr>
<tr>
<td>Taiwan</td>
<td>75</td>
</tr>
<tr>
<td>France</td>
<td>71</td>
</tr>
<tr>
<td>Japan</td>
<td>65</td>
</tr>
<tr>
<td>Germany</td>
<td>64</td>
</tr>
<tr>
<td>Israel</td>
<td>58</td>
</tr>
<tr>
<td>Brazil</td>
<td>57</td>
</tr>
<tr>
<td>Mexico</td>
<td>56</td>
</tr>
</tbody>
</table>
Many international students remain in the U.S. after graduation. The graph below shows the post-graduation plans of international students graduating in 2012, as reported in a survey administered by MIT. Overall, 76 percent of international students plan to remain in the U.S. after graduation.

### International Alumni Entrepreneurs

A 2009 Kauffman Foundation report on the Entrepreneurial Impact of MIT found the following:

Alumni who were not U.S. citizens when admitted to MIT founded companies at different (usually higher per capita) rates relative to their American counterparts, with at least as many remaining in the United States as are returning to their home countries....

About 30 percent of the foreign students who attend MIT found companies at some point in their lives. This is a much higher rate than for U.S. citizens who attend MIT. We assume (but do not have data that might support this) that foreign students are more inclined from the outset to become entrepreneurs, as they had to seek out and get admitted to a foreign university, taking on the added risks of leaving their families and their home countries to study abroad. (MIT has only its one campus in Cambridge, Mass., and, despite collaborations in many countries, does not operate any degree program outside of the United States.) We estimate that about 5,000 firms were started by MIT graduates who were not U.S. citizens when they were admitted to MIT. Half of those companies created by “imported” entrepreneurs, 2,340 firms, are headquartered in the United States, generating their principal revenue ($16 billion) and employment (101,500 people) benefits here.
International Alumni

MIT alumni and scholars have made extraordinary contributions in their home countries, the U.S., and the world. The following are some examples:

Kofi Annan, SM Management 1972
Kofi Annan, the seventh Secretary-General of the United Nations and recipient of the Nobel Peace Prize, was born in Kumasi, Ghana, and attended the University of Science and Technology in Kumasi before completing his undergraduate studies at Macalester College in St. Paul, Minnesota. He undertook graduate studies in economics at the Institut universitaire des haute etudes internationals in Geneva, and earned his SM in Management as a Sloan Fellow at MIT. Annan worked for the World Health Organization and the Ghana Tourist Development Company, but has spent most of his career at the United Nations.

Mario Draghi, PhD Economics 1977
Mario Draghi is the president of the European Central Bank (ECB) which sets interest rates for the 17 countries in the Eurozone. He was previously the governor of the Bank of Italy and, in 2012, Forbes Magazine nominated him as the 8th most powerful man in the world. Shortly after becoming president of the ECB, he oversaw a €489 billion ($640 billion), three-year loan program to European banks. He also stepped up the bond purchases from struggling Eurozone nations to help with the debt crisis. Draghi was born in Rome in 1947. He received a degree in economics from Universita degli Studi, Rome in 1970 before attending MIT. While at MIT, he studied with Nobel winners Franco Modigliani and Robert Solow.

Benjamin Netanyahu, SB Architecture 1975, SM Management 1976
Current Prime Minister of Israel, Benjamin Netanyahu was born in 1948 in Tel Aviv, Israel and grew up in Jerusalem. He served as Israel’s ambassador to the United Nations from 1984 to 1988, during which time he led the effort to declassify the United Nations’ archive on crimes committed by Nazi Germany. Netanyahu, a member of the Likud party, was Israel’s Prime Minister from 1996 until 1999. During his first term as Prime Minister, Netanyahu implemented policy that combined fighting terror with advancement of the peace process. Its cornerstone was the conclusion of well-measured agreements with the Palestinians that insisted on reciprocity. During his three-year term, the number of terror attacks drastically decreased.

Ngozi Okonjo-Iweala, MCP 1978, PhD Planning 1981
Currently the Managing Director of World Bank, Ngozi Okonjo-Iweala was the first woman to hold the position of Finance Minister in Nigeria. During her term from 2003 to 2006, she launched an aggressive campaign to fight corruption. She implemented a series of economic and social reforms, including a zero-tolerance policy for corruption; international and local governmental contract bidding; privatizing state-owned refineries; and the Extractive Industry Transparency Initiative, which aims to bring openness to the oil sector. Under her leadership, the country has tripled its reserves from $7 billion to $20 billion; the annual GDP grew at 6 percent; and inflation is down from 23 percent to 9.5 percent. Okonjo-Iweala started her career at the World Bank, where she was the first woman ever to achieve the positions of vice president and corporate secretary.

I. M. Pei, SB Architecture 1940
Ieoh Ming Pei, influential modernist architect and founder of the firm Pei Cobb Freed & Partners, was born in China in 1917. He completed his Bachelor of Architecture degree at MIT in 1940. Pei has designed more than 60 buildings, including the John Fitzgerald Kennedy Library in Boston, Massachusetts, the Grand Louvre in Paris, France, the Miho Museum in Shiga, Japan, the Bank of China Tower in Hong Kong, and the Gateway Towers in Singapore.

Tony Tan, SM Physics 1964
Following his degrees from MIT and his Ph.D. from the University of Adelaide in applied mathematics, Tan taught mathematics at the University of Singapore. Tan was elected to the Parliament of Singapore in 1979, and has served in numerous leadership positions in the Singapore government. In December 1991, Tan stepped down from the Cabinet to return to the private sector as the Overseas-Chinese Banking Corporation’s Chairman and Chief Executive Officer. He rejoined the Cabinet in 1995 as Deputy Prime Minister and Minister for Defense. In August 2003, Tan became Deputy Prime Minister and Co-ordinating Minister for Security and Defense. Tan won the Singapore presidential election in 2011 and is currently serving as the 7th President of Singapore.
International Scholars

MIT hosts many international researchers and faculty who come to the U.S. for teaching, research, collaboration, and other purposes. These include visiting scientists, professors, artists, and scholars, as well as postdoctoral fellows and associates, lecturers, instructors, research associates and scientists, and tenure-track faculty. During the year July 1, 2011 through June 30, 2012, MIT’s International Scholars Office (ISchO) served 2,175 international scholars affiliated with MIT and their accompanying family members (“international” is defined as non-U.S. citizen, non-U.S. permanent resident).

This reflects an increase of approximately 5.3 percent over last year (2,060). According to the Institute of International Education Open Doors 2011–2012 report, MIT ranked 10th nationally with regard to the numbers of international scholars at U.S. institutions. Postdoctoral associates and postdoctoral fellows accounted for 55 percent of MIT’s international scholars.

Foreign national scholars came to MIT from 90 countries, with the highest numbers coming from China, Korea, India, Germany, Canada, Japan, Italy, Spain, France, and Israel. The top ten countries of origin of the entire international scholar population in the U.S. are roughly the same. Scholars from these top 10 countries constituted 68 percent of MIT’s international scholar population. The greatest number of international scholars came to the School of Engineering, followed by the School of Science, interdisciplinary laboratories and centers, and the Sloan School of Management. Seventy-seven percent of international scholars were men and 23 percent were women.
Selected Projects

Research advances therapy to protect against dengue virus

Nearly half of the world’s population is at risk of infection by the dengue virus, yet there is no specific treatment for the disease. A therapy to protect people from the virus could finally be a step closer, thanks to a team at MIT. For most people the virus causes flu-like symptoms. But for some, particularly children, the virus can develop into dengue hemorrhagic fever, causing severe blood loss and even death. Developing a vaccine against dengue has so far proved challenging, according to Ram Sasisekharan, because dengue is not one virus but four different viruses, or serotypes, each of which must be neutralized by the vaccine.

Researchers led by Sasisekharan chose as their model an antibody known as 4E11, which has been shown in tests to neutralize dengue 1, 2 and 3, but not dengue 4. Taking a statistical approach, they then ranked physical and chemical features of the antibody in terms of their importance. This significantly narrowed the number of possible changes, or mutations, the researchers needed to make to antibody 4E11 in order to improve its ability to neutralize all four viruses, in particular dengue 4. As a result, the researchers came up with just 10 possible mutations after further investigation.

When they tested their mutated antibody on samples of the four dengue serotypes in the laboratory, they found it had a 450-fold increase in binding to dengue 4, a 20-fold increase in binding for dengue 2, and lesser improvements in binding for dengue 1 and 3, Sasisekharan says. They are now preparing for potential preclinical trials, and hope to be ready to test the antibody on humans within the next two to three years. In the meantime, they are also investigating other targets for their immunotherapy approach, including the influenza virus.

This work was funded by the National Institutes of Health and the National Research Foundation Singapore through the Singapore-MIT Alliance for Research and Technology's Infectious Diseases Research Program.

Chips with self-assembling rectangles

Researchers at MIT have developed a new approach to creating the complex array of wires and connections on microchips, using a system of self-assembling polymers. The team’s solution creates an array of tiny posts on the surface that guides the patterning of the self-assembling polymer molecules. This turns out to have other advantages as well: In addition to producing perfect square and rectangular patterns of tiny polymer wires, the system also enables the creation of a variety of shapes of the material itself, including cylinders, spheres, ellipsoids, and double cylinders. The work could eventually lead to a way of making more densely packed components on memory chips and other devices. The new method was developed by MIT visiting doctoral student Amir Tavakkoli of the National University of Singapore, along with graduate students Adam Hannon and Kevin Gotrik and professors Caroline Ross, Alfredo Alexander-Katz, and Karl Berggren.


The research, which included work at MIT’s Nanostructures Laboratory and Scanning-Electron-Beam Lithography facility, was funded by the Semiconductor Research Corporation, the Center on Functional Engineered Nano Architectonics, the National Resources Institute, the Singapore-MIT Alliance, the National Science Foundation, the Taiwan Semiconductor Manufacturing Company and Tokyo Electron.

A cooler way to protect silicon surfaces

Silicon, the material of high-tech devices, requires a surface coating to prevent oxidation that would ruin its electrical properties. Italian energy company Eni S.p.A., under the Eni-MIT Alliance Solar Frontiers Program, supported research where silicon is protected in a process that never heats the silicon above room temperature. See page 82 for more information.

Continuous drug manufacturing

Traditional drug manufacturing is a time-consuming process. An MIT and pharmaceutical company Novartis research effort, known as the Novartis-MIT Center for Continuous Manufacturing was created to transform those procedures. MIT researchers have developed and demonstrated a prototype continuous-manufacturing system. See page 82 for more information.
## Campus Research Sponsored by International Organizations

### International Organizations Campus Research Expenditures (in U.S. Dollars)

#### Fiscal Years 2008-2012

<table>
<thead>
<tr>
<th>International Sponsor Type</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundations and other nonprofits</td>
<td>11,299,312</td>
<td>17,314,194</td>
<td>23,170,052</td>
<td>20,233,545</td>
<td>25,025,346</td>
</tr>
<tr>
<td>Government</td>
<td>17,444,906</td>
<td>26,299,968</td>
<td>32,633,438</td>
<td>32,471,318</td>
<td>37,712,878</td>
</tr>
<tr>
<td>Industry</td>
<td>25,582,009</td>
<td>31,988,543</td>
<td>40,642,427</td>
<td>45,603,282</td>
<td>48,133,890</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>54,326,226</strong></td>
<td><strong>75,602,705</strong></td>
<td><strong>96,445,918</strong></td>
<td><strong>98,308,146</strong></td>
<td><strong>110,872,115</strong></td>
</tr>
<tr>
<td><strong>Constant dollars</strong>*</td>
<td>58,396,824</td>
<td>80,148,565</td>
<td>101,265,060</td>
<td>101,188,454</td>
<td>110,872,115</td>
</tr>
</tbody>
</table>

*Constant dollars are calculated using the Consumer Price Index for All Urban Consumers weighted with the fiscal year 2012 equaling 100.*
Section 7
Service to Local and World Communities

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Local Programs 105
World Programs 106
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Service to Local and World Communities

Founded with the mission of advancing knowledge to serve the nation and the world, MIT has been strongly committed to public service from its start. While MIT faculty, students, and staff regularly engage in conventional projects such as raising money for hurricane victims, renovating old housing, or restoring local nature reserves, MIT’s scientific and technological orientation gives much of its public service outreach a particular emphasis. Many of its public service programs are specifically devoted to inventing new technologies and applying new knowledge that will advance social well-being.

Public Service Center

The Public Service Center (PSC) offers MIT students multiple ways to assist communities beyond MIT while expanding their own education and life experiences. The guidance, resources, and support offered by the PSC help students to identify public service options that suit their passions and abilities.

The PSC helps students gain hands-on experiences that serve communities and the students themselves in life-transforming ways. Through fellowships, internships, and grants; the IDEAS Global Challenge; programs such as Four Weeks for America and the Freshmen Urban Program (FUP); community service work-study positions; and advising resources, students have the opportunity to engage in a variety of opportunities.

http://web.mit.edu/mitpsc/

Fellowships, Value-Added Internships, and Grants

In locations as near as Boston or as far as Bangladesh, there are many opportunities to work on community issues, whether it is designing community spaces for domestic violence survivors in Boston, scrutinizing labor practices in the electronics industry in Mexico, or developing a business plan for villagers to produce and sell silk garments in Thailand. As a subset of its internships program, the PSC also offers specialized opportunities for students in the Department of Civil and Environmental Engineering and the Department of Urban Studies and Planning.

MIT IDEAS Global Challenge

Students form teams to design and implement innovative projects for community partners in order to improve the quality of life of individuals around the world. Since 2001, the IDEAS Global Challenge has awarded $500,000 to 100 student-led teams to make their ideas a reality. As a result of implementation funds awarded to teams, communities around the world have directly benefited from these innovations.

Programs, Planning, and Volunteering

Through local outreach programs, MIT students can work with a K–12 science classroom, serve as a mentor to adolescents in math and science, or teach a child to read. The PSC maintains the online MIT Outreach Directory of outreach programs offered throughout the Institute, many of which share MIT’s research endeavors with the public. Additionally, FUP, Giving Tree, and ReachOut are among the programs led by students under the direction of the PSC. In the Four Weeks for America program, students work with Teach for America teachers during the Independent Activities Period to help them develop innovative ways to teach science and math and increase classroom learning. Also, PSC staff advise students about volunteer opportunities, service group management, grants and proposal writing, and other areas that help MIT students and groups to participate in community service.
Office of Government and Community Relations
Since its founding, MIT has maintained a commitment to serving the local community as both a resource for education and technology and as a good neighbor. Through the Office of Government and Community Relations (OGCR), MIT works collaboratively with dozens of Cambridge nonprofits that address local challenges such as meeting the needs of underserved populations, youth development, and environmental sustainability. The Institute solidly supports these organizations by providing financial support as well as in-kind resources like meeting space, faculty expertise, and volunteer engagement. In addition, OGCR collaborates with the MIT Public Service Center and MIT Community Giving to manage the MIT Community Service Fund (CSF). The CSF provides support for nonprofits where MIT volunteers are at work and encourages the creation of new community service projects by providing grants to MIT affiliates.

Service to the community is not just centralized in one office, the Institute’s various Departments, Labs and Centers have a diverse array of programs aimed at giving back to its host community.

Local Programs
Amphibious Achievement
Amphibious Achievement is an MIT student group that mentors high school students in the Boston-Cambridge area in both athletics and academics. Under the guidance of MIT student coaches/tutors, Amphibious Achievers train to row and swim competitively while also working on critical reading techniques, math problem solving, and grammar comprehension in an SAT-based curriculum.

http://amphibious.mit.edu

Cambridge Science Festival
The annual Cambridge Science Festival, the first of its kind in the United States, is a celebration showcasing Cambridge as an internationally recognized leader in science, technology, engineering, and math. The festival is presented by the MIT Museum in collaboration with the City of Cambridge, community organizations, schools, universities, and businesses. A multifaceted, multicultural event held every spring, the festival makes science accessible, interactive, and fun, while highlighting the impact of science on all our lives.

CityDays Serve-Off
More than 190 MIT students volunteered at 13 sites in the greater Boston area for the 2012 CityDays Serve-Off. Student volunteers prepared materials for classrooms of low-income children, provided adults with literacy training and sorted clothes for thrift stores that support AIDS research, among many other service activities.

Edgerton Center—K–12 Programs
The Edgerton Center continues the learning-by-doing legacy of “Doc” Edgerton. The Center’s K–12 programs educate, inspire, and motivate kindergarten through 12th grade students through hands-on science and engineering challenges with the aim of increasing students’ curiosity and desire to pursue these fields in their future. Concentrating in the Greater Boston area, with selected out-of-state and foreign endeavors, the Edgerton Center’s multifaceted approach supports over 150 on-campus classroom workshops annually, intensive summer programs, innovative curriculum and professional development workshops for teachers. As well, Edgerton Center instructors mentor faculty and students in local public schools. In all aspects of these programs, MIT students are closely involved. All of the programs are provided at no or minimal cost.
Local Programs (continued)

Educational Studies Program
Founded by students in 1957, the MIT Educational Studies Program (ESP) shares knowledge and creativity with local high school students in the Boston, Cambridge, and MIT communities. Through an extensive offering of academic and non-academic classes, ESP is dedicated to providing a unique, affordable educational experience for motivated middle school and high school students. ESP courses are developed and taught by MIT students, alumni, faculty, and members of the community.

http://esp.mit.edu/

Freshman Urban Program
The Freshman Urban Program is a freshman pre-orientation program that introduces students to MIT and the surrounding community through service activities and discussion of urban issues. Projects have included service such as cleaning and preparing elementary school classrooms for the new school year, gardening with CitySprouts, and working at the Boston Rescue Mission. Community service combined with urban exploration provides incoming students with the means to meet people and to get involved in the community.

Giving Tree
The MIT Giving Tree allows students, alumni, faculty, staff, and friends to provide gifts to needy children in the Cambridge and Boston area each holiday season. The MIT Public Service Center and Panhellenic Association work with 12 local agencies to collect gift requests from hundreds of children. Each gift request is then individually matched to a Giving Tree participant, making the Giving Tree a more personalized experience for everyone.

World Programs

Abdul Latif Jameel Poverty Action Lab
The Abdul Latif Jameel Poverty Action Lab (J-PAL) is a global network of researchers who use randomized evaluations to answer critical policy questions in the fight against poverty. J-PAL works to achieve this by conducting rigorous impact evaluations, building capacity of others to conduct randomized evaluations, and translating research findings into policy action. J-PAL is organized both by regional offices and by research programs. J-PAL’s headquarters is a center within the MIT Department of Economics, with independent regional offices in Africa, Europe, Latin America, South Asia, and Southeast Asia that are hosted by local universities. J-PAL’s research programs include Agriculture, Education, Environment and Energy, Finance, Health, Labor Markets, and Political Economy and Governance.

http://www.povertyactionlab.org/

D-Lab
D-Lab is building a global network of innovators to design and disseminate technologies that meaningfully improve the lives of people living in poverty. The program’s mission is pursued through interdisciplinary courses, technology development, and community initiatives, all of which emphasize experiential learning, real-world projects, community-led development, scalability, and impact assessment. Founded by Amy Smith, Senior Lecturer in Mechanical Engineering, D-Lab has developed a range of technologies and processes including community water testing and treatment systems, human powered agricultural processing machines, medical and assistive devices for global health, and clean-burning cooking fuels made from waste. All D-Lab classes and projects are connected to communities around the world, including partners in Brazil, Nicaragua, Honduras, Guatemala, El Salvador, Haiti, Ghana, Tanzania, Uganda, Zambia, Cambodia, and India.

http://d-lab.mit.edu/
International Development Innovation Network
The International Development Innovation Network (IDIN) is an international consortium of institutions led by MIT's D-Lab that are building a network of innovators to better define international development problems and the constraints surrounding them, prototype multiple solutions to these challenges, perform comparative evaluations to move the most promising solutions forward, and incubate ventures to disseminate the solutions. The Consortium is building the network by training people from a wide variety of backgrounds to become innovators and entrepreneurs through hands-on, creative capacity-building design summits and focused entrepreneurship training modules and programs. In addition to MIT, IDIN consortium institutions include Olin College of Engineering, Colorado State University, University of California-Davis, University of São Paulo, and Kwame Nkrumah University of Science and Technology. IDIN is part of the Higher Education Solutions Network, a ground-breaking partnership between USAID and top U.S. and foreign universities committed to developing innovative solutions to global development challenges.

http://d-lab.mit.edu/idin

Comprehensive Initiative on Technology Evaluation
The Comprehensive Initiative on Technology Evaluation (CITE), led by MIT's Department of Urban Studies and Planning, is developing a rigorous methodology for evaluating technological solutions to challenges in the developing world, eventually leading to the development of comparative Technology Evaluation Reports. These reports will help donors and policy-makers identify and invest in the best of these solutions. The program includes a biannual DevTech conference, a CITE Fellows program, as well as product design challenges to assist the private sector, researchers, innovators and students in targeting the most intractable development problems and create a pipeline of innovative technology options for the development community. CITE is part of the Higher Education Solutions Network, a ground-breaking partnership between USAID and top U.S. and foreign universities committed to developing innovative solutions to global development challenges.

http://d-lab.mit.edu/cite

Legatum Center for Development and Entrepreneurship
The Legatum Center for Development and Entrepreneurship at MIT was founded on the belief that economic progress and good governance in low-income countries emerge from entrepreneurship and innovations that empower ordinary citizens. The center administers a highly competitive fellowship program for MIT graduate students who intend to launch innovative and inclusive for-profit enterprises in developing countries. In addition to supporting the Legatum Fellows, the Legatum Center aims to catalyze entrepreneurship for broad-based prosperity by administering programs including case writing, research, articles, lectures, conferences, and seed grants.

http://legatum.mit.edu/

International Development Grants
These grants support international development projects that involve MIT students. Faculty, students, and other MIT community members can use them to cover materials, travel, and other expenses in projects that serve communities in developing regions.
**Selected Projects**

**Chlorine Dispensers for Safe Water**
Research by J-PAL affiliates has shown that a point-of-collection water chlorination system, in combination with encouragement from community promoters, can dramatically increase access to safe water compared to marketing bottled chlorine through retail outlets. Evidence from their studies has contributed to the scale-up of the Chlorine Dispenser System reaching over 400,000 people in Kenya and 20,000 people in Haiti, with plans to expand the program to at least two additional countries by 2014.

http://www.povertyactionlab.org/scale-ups/chlorine-dispensers-safe-water

**Helping Brazilians turn waste into products**
Brazilian waste pickers, called catadores, are highly adept at making the most out of their nation’s waste. But a monthlong summit co-led by MIT engineers worked with them to find ways of further expanding the recycling and repurposing of waste materials, finding ways to produce food in close-packed urban favelas, or shantytowns, and ways to turn trash into floor tiles, among other projects.

The event, the sixth annual MIT-spawned International Development Design Summit, was the first to be held in Latin America, the first to be conducted entirely bilingually, the first with an urban focus, and the first to be largely organized by local people in the host country.


**Bringing power to the people—and heat as well**
In some isolated clinics in parts of Africa, the electricity needed to power lights and medical devices is generated by expensive imported diesel fuel; the water supply can be so cold in winter that health workers can’t even wash their hands properly. But a startup company established by a team of MIT students and alumni aims to change that.

The patented technology they developed uses a mirrored parabolic trough to capture sunlight, heating fluid in a pipe along the mirror’s centerline. This fluid then powers a sort of air conditioner in reverse: Instead of using electricity to pump out cold air on one side and hot air on the other, it uses the hot fluid and cold air to generate electricity. At the same time, the hot fluid can be used to provide heat and hot water—or, by adding a separate chiller stage, to produce cooling as well.

A prototype of the system has been installed at a small clinic in the southern African nation of Lesotho. The MIT team plans to have five fully operational systems installed in isolated clinics and schools there for field-testing in 2013.
